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INSIDE

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2012 CALENDAR
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Cover and this page: It's the centennial of US aviation, but a robot – not a pilot – may own the future. Able to reach high subsonic speeds, the X-47B unmanned aerial vehicle is vying for primacy against piloted aircraft. The X-47B's first carrier landing is planned for 2013.

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albert einstein

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PUBLISHED BY: RamsayMedia (Pty) Ltd

Chairman: Alan T Ramsay
Managing Director: Stuart Lowe
Directors: Terry Moolman, Gordon Utian, Brian Burnett, James Eedes,
Simon Turck, Tim Holden, Peter Venn
HR Executive: Amanda Kirk



Total monthly sales: 43 583 (July to September 2011)

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Company registration number: 1934/005460/07, ISSN number: 1682-5136

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The IDC is involved in the facilitation and provision of development finance for the mass roll-out of Solar Academy of Sub-Saharan Africa (SASSA) solar water heaters.

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that warms a million bathtimes*



INVENT 2011 is over. Now will someone please turn off the lights

It was excruciating. The laser equipment was in place, the audience was primed and expectant, and the violinist lurked just off-stage, waiting for her cue. As a machine-generated haze spread through the auditorium, I signalled to the man in the control booth to turn off the lights, then settled back in my chair and prepared to experience a spectacular opening to the third annual POPULAR MECHANICS Inventors Conference.

Seconds passed as if mired in treacle, and the lights stayed on. The laser guy looked at me quizzically. This wasn't good. I signalled frantically to a figure in the dimly lit booth at the back of the auditorium: *Lights off!*

Nothing happened. One of my colleagues scrambled to his feet and slipped into the booth; I noticed a fair amount of gesticulating. Seconds later, some lights went off and others came on. By now I was beginning to perspire, and decided to appeal to the audience: Had anyone brought a catapult? Perhaps we could shoot out the lights.

To cut a long and painful story short – and believe me, five minutes is akin to a lifetime when 120 people are staring at you and waiting for something to happen – we eventually determined that it was impossible to turn off all the lights at once (don't ask) and reluctantly proceeded with the laser show in a partly-lit auditorium. It was excellent, by the way, and our sincere thanks go to the friendly and highly professional team from LaserX, not to mention a lithe and talented violinist named Kristel.

There was more. Our flight had been delayed by several hours, so we arrived at the venue late and hungry. This meant we were unable to conduct a "dry run" – an essential step in the run-up to a conference, especially if some of the presentations are delivered minutes before kick-off in the form of unlabelled DVDs and anonymous flash drives. Oh, and did I mention that PC-generated presentations sometimes don't talk to Macs, or that seemingly perfect videos may develop severe attitude problems when transported to other cities?

In the end, however, none of this really mattered. Our presenters performed magnificently, delivering a heady mix of practical advice and inspirational stories of inventiveness and entrepreneurial derring-do. A remarkably versatile entertainer named Peter Greenwall provided light relief when we needed it most, and during our "punctuation moments", delegates interacted with a bunch of interesting exhibits, including a turbine-powered car (built by a team from the University of Johannesburg) and rapid prototyping machines (courtesy of the Vaal University of Technology).

Later, after a deliciously languid 10-minute break to shower and change, we assembled in an adjoining room for a black-tie awards function marking the finale of the inaugural POPULAR MECHANICS Inventors Competition. Having named Dr George Vicatos (bottom left) as Inventor of the Year for 2011, I presented him with a floating trophy, announced that he would be receiving R50 000 in prize money, and mentioned that I couldn't imagine a more worthy winner.

When I sat down, one of my colleagues leaned across and commented: "For a moment there, you sounded quite emotional." I thought about it. He was probably right, but it was okay.

Alan Duggan

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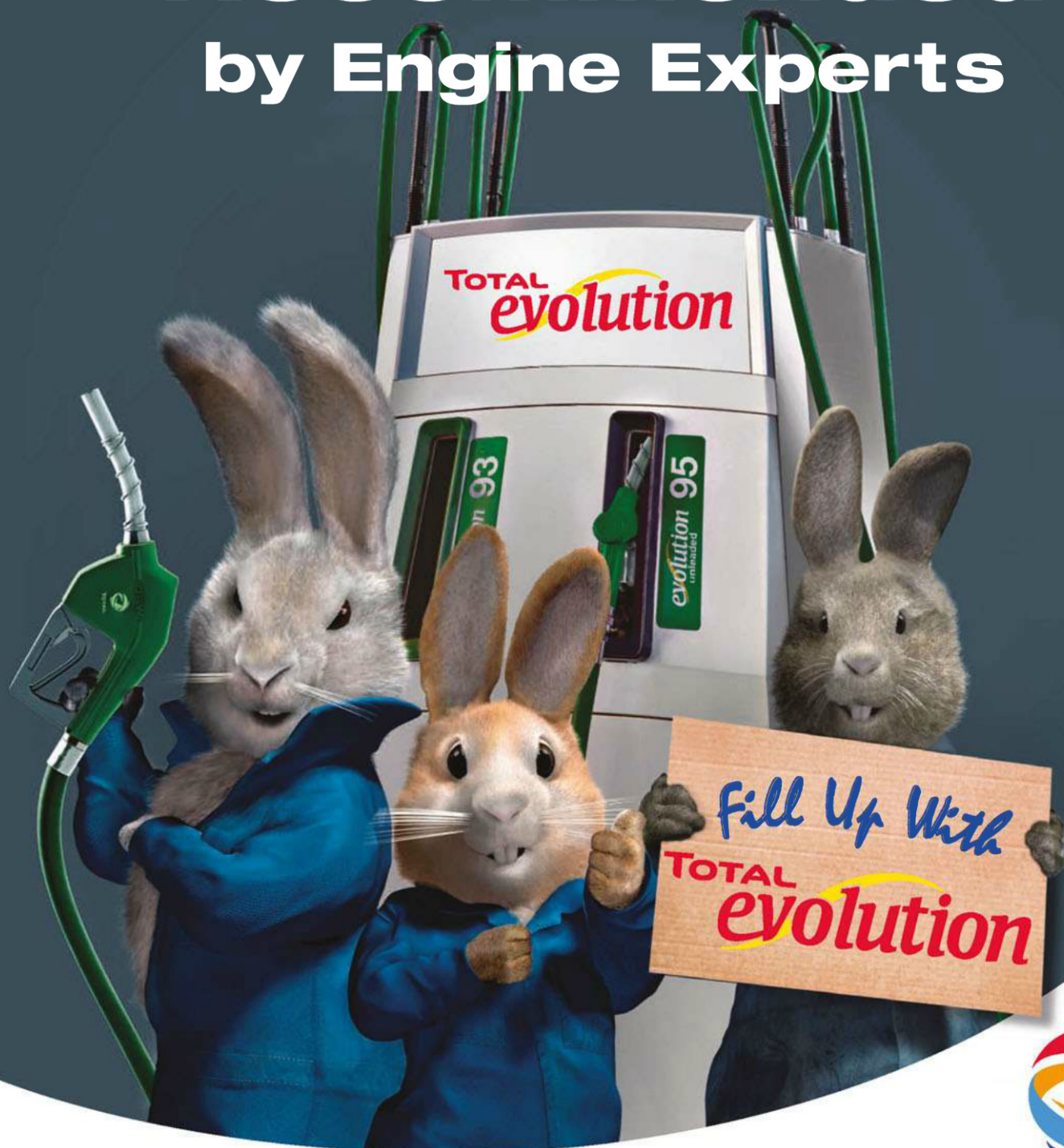
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**9
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WINNING
LETTER

ACCIDENT? BE SURE TO CAPTURE THAT CRUCIAL EVIDENCE

When you're involved in a road accident, you may have many things on your mind: you're shocked, upset about the damage to your car, worried about the cost of repairs, whether your insurance is up to date, and so on. While under the influence of these emotions, you might grab a cellphone and use the camera to document the damage to your car, but forget to gather other vital evidence.

My advice: don't be too focused on the damage on your own car. You may have plenty of time to photograph it afterwards, since it will remain under your control. Instead, think about the bigger picture. Photograph any road signs or landmarks in the area, and the position and orientation of your own and other vehicle/s in relation to the landmarks to show where and how they came to rest. That done, photograph the other car from all angles, since it may be moved or the driver may even disappear, in which case you could face a claim for much more than the damage incurred in your accident.

Also photograph the car's make and model, the colour (from close up if it's after dark), the registration number as well as the license disc. Next, document the damage to that car as well parts of the car that were *not* damaged, and where old damage is visible. Photograph each tyre in turn to show the condition of the tread. If you can, also photograph the licence cards of all drivers involved.

Then, when you are done with the other car, or the other party has left, do the same for your own car. Finally, you should photograph any tyre or skid marks on the road surface. If you need to present evidence in court at a later stage, these photographs could make or break your case. Most modern cellphones are equipped with excellent cameras that can capture images from close-up and even record video. In short: photograph the evidence and not the accident. An objective investigation will be well-received in court but if you are only drumming on about the damage to your own car, you will be seen as self-serving and biased. If the other party attempts to inflate the damage to his car, your photographic evidence can prove otherwise.

STAN BEZUIDENHOUT
FORENSIC COLLISION HOMICIDE RECONSTRUCTIONIS

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Send your letter to: Popular Mechanics, PO Box 180, Howard Place 7450 or e-mail popularmechanics@ramsaymedia.co.za Please keep it short and to the point. Regrettably, prizes can be awarded only to South African residents.



Hail the sport-and-beer guys

I must be honest and tell you that when my girlfriend came home a few months ago and proudly announced that she had bought me a subscription to your magazine, I had to fake a smile of appreciation. I actually wondered whether she had bought it for her son, a typical 15-year-old boy

with interests in all new tech, PCs, cell-phones, etc.

I'm more of a sport and beer kind of guy. I have a laptop (for work purposes), I can access my e-mail, do online banking, surf the Net for sports results, and book airline tickets. I've got 12 gigs of great music and thousands of pictures stored in

my laptop. I make the occasional online booking or purchase, and that is about the sum total of my computer literacy. Anyway, my point is that I'm not much into technology, gadgets and mechanics. I certainly would not have intentionally picked up a copy of PM off a CNA shelf!

The first copy of your magazine arrived in our post box, and remained in its plastic wrapper for a few weeks – until the day I ran out of other reading material. I flicked through the pages and soon found an article that caught my eye. A few pages later, I was pleasantly surprised to find another interesting article in the magazine. The more I paged, the more articles of personal interest I found. The next magazine was quickly devoured.

What I find most impressive is that your journalists have a knack of imparting their knowledge in a language that I (and my "normal" friends) can understand, rather than confusing me with IT-speak, acronyms and arcane terminology.

I'm now a converted "sports and beer" guy, and can even converse knowledgeably with the IT guys at the office when they rave about the latest geek toys to hit the shelves. Thanks for achieving a good balance between geek-type technology content and great-to-know stuff that I can impart to my buddies around the braai (with beer in hand) without killing the conversation.

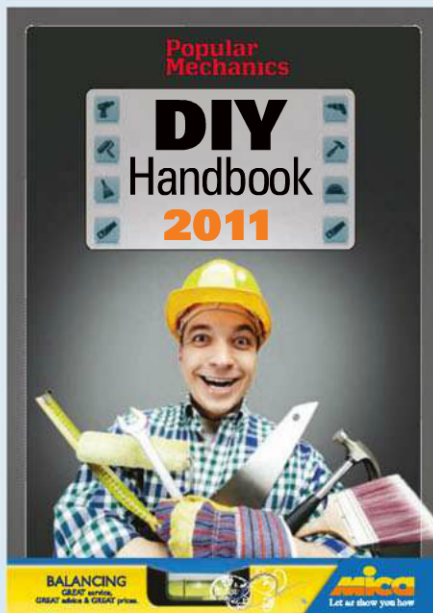
SCOTT DAWSON
KEMPTON PARK

So global warming is a scam?

For a magazine supposedly based... on science, POPULAR MECHANICS seems remarkably incurious. For example, Sean Woods seems to have bought in to the global warming scam: "CO₂ may grab the headlines for its contribution to global warming, but methane is a much bigger villain." Do you not know that life on Earth would not be possible without CO₂? That the "correct" level is indeterminable with the state of current knowledge?

What is never stated in articles such as this is: what is the price of power to the consumer? I suspect that consumers are in for a very nasty surprise when they finally discover the price. What astounds me the most is that the media is completely silent on the matter of price, having completely bought in to the global warming scam. Are the members of the media oblivious to the fact that they will also have to pay this price, and that the price will make electricity even more inaccessible to the poor, about whose welfare so many pretend to care so much?

POPULAR MECHANICS regularly reports on research in the field of non-hydrocarbon



Sick, bro

So I was getting on the bus for a return trip to PE from Cape Town. Browsing the magazine stand, bypassing the usual men's and bikini model magazines, I happened to glance over PM, and without hesitation I grabbed it and fascinated myself in the content for 12 hours straight. See, I'm a recent student who lived in digs, and jolled and did all the studenty stuff, but what got me purchasing your mag (for the first time ever, nogal) was the DIY Handbook. It dawned upon me that as a student, I could sleep late, party all hours of the day, chill on the beach, hang out at uni.... blah blah blah, but could I do Man stuff around the house? No!

Some very useful bro tips from readers in that handbook actually came in handy when I arrived back at my digs to a house party with plentiful ladies. The handbook helped me out in three ways, namely: "Get a grip" – I ended up using this technique to open a bottle for a lady; "Beer can horror" – this really happened, and I saved the day; and lastly "T-shirt cannon" – this was attempted, but not so successful after numerous fixes with beer can horror.

I gotta say thanks for the useful info. These are things universities should offer in orientation for students!

RYAN MOSS
PORT ELIZABETH

Editor's note: Since this was written in the vernacular, we won't hesitate to respond in kind: Thanks, Ryan. Sick letter, bro. Students rule.

power generation but never seems to make the connection that any generation plant built now is very likely to be obsolete before it generates a single watt. COP17 is likely to be a dismal failure and, hopefully, the last of the whole COP charade. COP15 was a failure (with South Africa promising emission reductions that everyone knows were a joke and were never intended to be achieved); COP16 turned into nothing more than a shopping trip for the delegates. The whole global warming scam is finally reaching its end.

The scam started when (mostly) whites from (mostly) affluent countries started to tell (mostly) non-whites from (mostly) non-affluent countries that the latter would never be allowed to reach the standard of living achieved by the former. The non-whites have belatedly realised this and (particularly China) are unlikely to agree to Kyoto II. It is stated that there must be a "legally binding agreement". Under what law? There is none.

Thank goodness for the recession, which has prevented the spending of money which the world does not have on technology that is dubious, to say the least, to address a problem that does not exist.

PETER DARLEY
VIA E-MAIL

Editor's note: May we also presume that the 9/11 attacks were part of an alien conspiracy?

Landfill gas? We thought of it, too

The initiative to use methane gas from landfill sites ("Burn it up", November issue) is a wonderful idea because of the positive impact on the environment and the economy.

More than 15 years ago, I was involved with the Cape Town City Council on a project to power municipal vehicles from the methane gas drawn off landfill sites. We had a pilot plant operating for roughly a year but, unfortunately, bureaucracy prevailed and the project was shelved.

As explained in your article, it is easy to capture the methane and compress the gas to a higher pressure and store it in large receivers (tanks). From there it is decanted directly into small receivers installed on the municipal vehicles. In our case, the vehicles had a simple modification to their fuel system to accommodate the correct jetting for methane (they had a dual fuel system for petrol or methane). The average range from a gas fill was about 250 km. This means that the council could have had free energy for their fleet of cars, bakkies and small trucks, with only a modest capital investment for the conversion of vehicles, receivers and compressors. There was no need to flare off the excess methane; we

would use it. We calculated that payback would take less than one year – and that was when petrol was cheap. This is an ideal companion to generating power from landfill sites, and I hope that the idea will be re-explored.

BOB SAVAGE
VIA E-MAIL

Okay, we'll remember this

I've enjoyed POPULAR MECHANICS for many years and can't wait every month until my copy arrives in my post box. Unfortunately, this issue is the first one that has upset me. On page 42, in the Great Stuff section, an article titled "Boost your memory" refers to a laptop hard drive as "memory". This is exactly the kind of misinformation that results in arguments with those that have read such articles and trust the information as it was published in a "technologically informed" magazine.

There is a huge difference between computer memory, which is only a temporary data processing area while power is applied, and a hard drive, which normally has a significantly larger capacity and of course does not require power to be applied for the data to be retained.

Sure, hard drive technology is changing and already solid state drives are available that are technically a form of memory, but there is still a distinction between computer memory and a computer's data storage device in the form of the hard drive (be they physical platters or solid state).

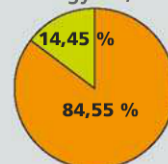
Enough moaning from me. I still love the magazine and will definitely continue reading it for many years.

RHYS MCWILLIAMS
VIA E-MAIL PM

MONTHLY POLL

Plans to convert methane from all landfill sites in SA into electricity would generate about 100 MW (compared with Eskom's 37 500 MW). Is it worth it?

Yes. Methane gas is a significantly harmful greenhouse gas and is also a serious health hazard. Go for it. 84,55%
No. We should rather concentrate on other, more effective ways to produce renewable energy. 15,45%



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1955 Unmanned aerial vehicles (UAVs) may radiate cutting edge technology, but their development actually dates back more than half a century. This was the year that the Kaman Aircraft Corporation began flight tests of a remote-controlled Karman HTK-1 helicopter. Fitted with an automatic pilot and radio controls, it was successfully flown by an operator on the ground. Just to be safe, a standby safety pilot occupied the aircraft on all its flights.

How to Keep
from Crying
When Peeling
Onions; Wear a
Gas Mask



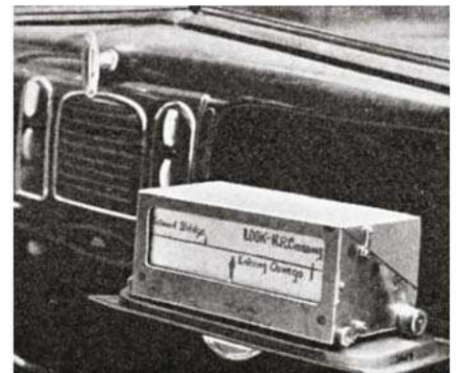
1929

You can never be too careful when peeling onions. Billed as the answer for teary-eyed housewives, this war surplus gas mask was specially adapted for domestic use to prevent onion fumes from affecting the nostrils and eyes. It was apparently easy to slip on or off and provided unobstructed vision through its wide lenses. It was also touted as a solution for hay fever sufferers wanting to avoid dust.



1964 Although the principles behind electrohydrodynamic (EHD) devices have been understood for a long time – they exploit a phenomenon known as the Biefeld-Brown effect to produce thrust in the air without requiring combustion or moving parts – finding a real-world use for them has remained rather elusive. When patented this “ionocraft” was optimistically billed as the flight mode of the future. It had one big drawback: to carry a payload in the order of a few grams, it needed a power source and a high-voltage converter that weighed several kilograms.

1940 Just because there were no GPS satellites didn't mean that drivers travelling on unfamiliar roads never reached their destination. That's because they could rely on a scrolling road map, synchronised to the vehicle via a speedometer attachment that unreeled during travel. As the map rolled past a window on the device, it indicated the approach of road markers, landmarks and points of interest. It also warned drivers of hazards such as sharp curves and dangerous crossings. It was said to be easy to “reckon” the distance between any two points. It could also be stopped temporarily if detours were made from the charted course.



PM

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Makes for 7,9 litres per 100km.
Makes the toughest jobs seem easy.



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The Amarok Single Cab is here. Its tremendous off-road capabilities ensure that even the toughest tasks in the hardest to reach places are child's play. With 400Nm of torque, a fuel consumption of 7.9l/100km*, a loading bay that allows for 2 Euro-sized pallets crossways and the ability to climb a 45° incline with a full load, it really is the superior choice if you want a hard-working single cab. Now there are more than enough reasons to put the old workhorse to rest.

Work hard. Work smart. Amarok Single Cab.

AMAROK
SINGLE CAB



**Commercial
Vehicles**

■ ALTERNATE ENERGY

Sailing on sunshine

A **solar-powered catamaran** that left Monaco in September 2010 is on schedule to complete its round-the-world cruise – the first fully solar-powered circumnavigation of the globe – in May 2012, if all goes according to plan. The MS *Tûranor Planet-Solar* produces five times the power needed to propel the vessel, filling a battery that provides power at nights, on cloudy days and for auxiliary needs such as water desalination. Of course, the trip isn't the first globe-spanning odyssey to rely on renewable energy: Ferdinand Magellan's crew finished the circumnavigation in 1522 in a ship powered by wind. – ALEX HUTCHINSON

⌘ SOLAR PANELS:
535 m²

⌘ PV PANEL
EFFICIENCY:
18,8%

⌘ PV POWER:
93,5 kW



VIDEO

> Visit www.popularmechanics.co.za to watch the Planet Solar trailer.



■ QUICK HITS

**Gem of a planet**

→ Using telescopes in Australia, Hawaii and England, an international team of astronomers has identified a planet that has more mass than Jupiter, but is only half as big. Scientists say this extreme density probably means it's made mostly of crystalline carbon – in other words, diamond – and oxygen. It's 4 000 light-years away, so mining companies won't be visiting there soon.

**Car talk**

→ Nearly 3 000 cars, trucks and buses will soon be "speaking" with the roads of Ann Arbor, Michigan, as part of a R120 million test of vehicle-to-infrastructure communication. Staff at the University of Michigan Transportation Research Institute will equip the vehicles with devices that broadcast their direction and speed via short-range radio. The researchers will also monitor nearly 400 vehicles fitted with receivers that will alert drivers if any other participating vehicles are approaching in an unsafe manner.

The results of the 12-month trial will help the US Department of Transportation evaluate possible regulations requiring the installation of connected-vehicle technology in new cars after 2013.

Illustrations by Tamer Koseli

■ PREHISTORY MYSTERY

Tool time

Lab experiments have shed light on an enduring question about humanity's relationship with tools. Measurements at Lamont-Doherty Earth Observatory's Paleomagnetism Lab outside New York City show that our ancestors had an impressive tool chest at least 1,76 million years ago, 300 000 years earlier than previously thought. The researchers were able to determine the date of sophisticated axes and other cutting tools found in Kenya by examining surrounding mudstone that preserved the direction of Earth's magnetic field. Because this field shifts periodically, paleontologists can analyse this record to fix the age of the sediments from which the tools were quarried. It proves that *Homo erectus*, a precursor to modern humans that died out 70 000 years ago, used axes with chiselled edges to butcher and maybe hunt large animals such as elephants. – ALEX HUTCHINSON



Researcher Craig Feibel uses the magnetic history of West Turkana, Kenya, to determine the date early man crafted stone axes.

**Pipe patches**

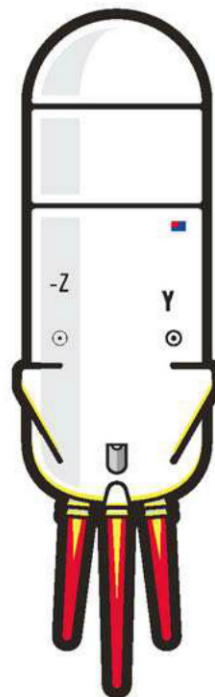
A University of Arizona engineering professor is borrowing tactics from cardiologists by using the civil engineering equivalent of a stent to fix leaking pipelines. The Gas Technology Institute recently completed a series of natural gas line tests on PipeMedic, which relies on a new "superlaminar" material made of crisscrossing carbon fibres with thin layers of glass fabric embedded in resin.

A coil of the flexible superlaminar is wrapped around a device that rolls hundreds of metres along the pipeline until it reaches the broken pipe. A balloon inflates to press the laminate into place – holding it there until the epoxy dries – and then it deflates, putting the pipe back in service. – AH

■ PRIVATE SPACE RACE

Secret spacecraft comes down to Earth

Secretive space firm Blue Origin, founded by Amazon.com CEO Jeff Bezos, was forced into the public eye when one of its experimental craft crashed in West Texas in late August. The unmanned spacecraft self-destructed after it lost control at 13 000 metres. "(It was) not the outcome any of us wanted," Bezos wrote on Blue Origin's Web site. The company is researching ways to enable spent booster engines to fly back to the ground and land vertically so that they can be reused. Modern boosters drop into the ocean and must be recovered by ships; private space companies hope to find big savings by having the used engines fly home on their own. – JOE PAPPALARDO



ROBOT SUPERHEROES

Built tough to go deep

Accidents killed 128 South African miners in 2010. Collapsed mines are dangerous for rescuers, making robots ideal first responders. But it takes a rugged machine to survive an underground emergency. The 85-kilogram Gemini-Scout Mine Rescue Robot, designed at Sandia National Labs, is built for the job. The US Mine Safety and Health Administration may deploy the bot in 2012. – ALEX HUTCHINSON



EXTRASENSORY PERCEPTION

GAS SENSORS AND A THERMAL CAMERA CAN DETECT IMPERILLED MINERS.

EASY TO RELATE TO

AN XBOX 360 CONTROLLER MAKES OPERATION INTUITIVE TO USERS.

IMPERVIOUS TO DAMAGE

ELECTRONICS ARE HOUSED IN WATER-PROOF CASINGS TO PREVENT METHANE GAS EXPLOSIONS.

SUPERHUMAN STRENGTH

THE 1,2 M-LONG 60 CM-HIGH ROBOT IS STRONG ENOUGH TO DRAG A SURVIVOR TO SAFETY.



21st-CENTURY MEDICINE

Microbial mind control

Can tiny organisms in our bellies control our emotions? Researchers at Canada's McMaster University have demonstrated how bacteria in the stomach can alter the mood of mice. Researchers fed mice a strain of *Lactobacillus rhamnosus*, a probiotic bacterium, then monitored their behaviour to gauge anxiety levels.

"These tests rely on the conflict between the urge of the mouse to explore a novel environment and its tendency to avoid potentially dangerous areas, such as open or brightly lit spaces," says assistant professor Paul Forsythe, one of the researchers involved with the study. "Anxious mice forego exploring in favour of staying safe." The mice with high levels of the bacteria in their guts proved more intrepid. When the researchers snipped the vagus nerve, which connects the brain and stomach – the nerve sends a signal to the brain to be more receptive to a chemical that influences calmness – mice with high bacteria levels were timid. This pinpointed the mind-belly connection.

Forsythe says he's optimistic that his research will lead to therapeutic use in humans. That doesn't mean anyone should use probiotics to try to relieve anxiety, especially since the strain he tested is not commercially available. "Until they have been tested, it is impossible to say if over-the-counter probiotics would have the same effect," Forsythe says. "The effects are very strain-specific. One type is not the same as another."

– AMIR KHAN

Visit www.popularmechanics.co.za to catch Sandia's Gemini-Scout Mine Rescue Robot in action.

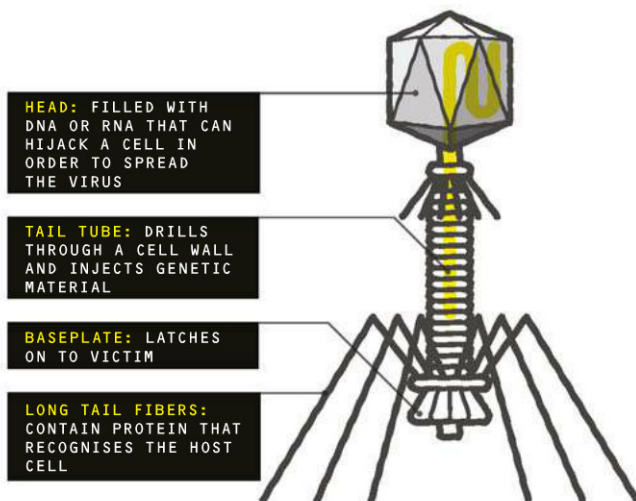
VIDEO



■ UNSEEN WORLDS

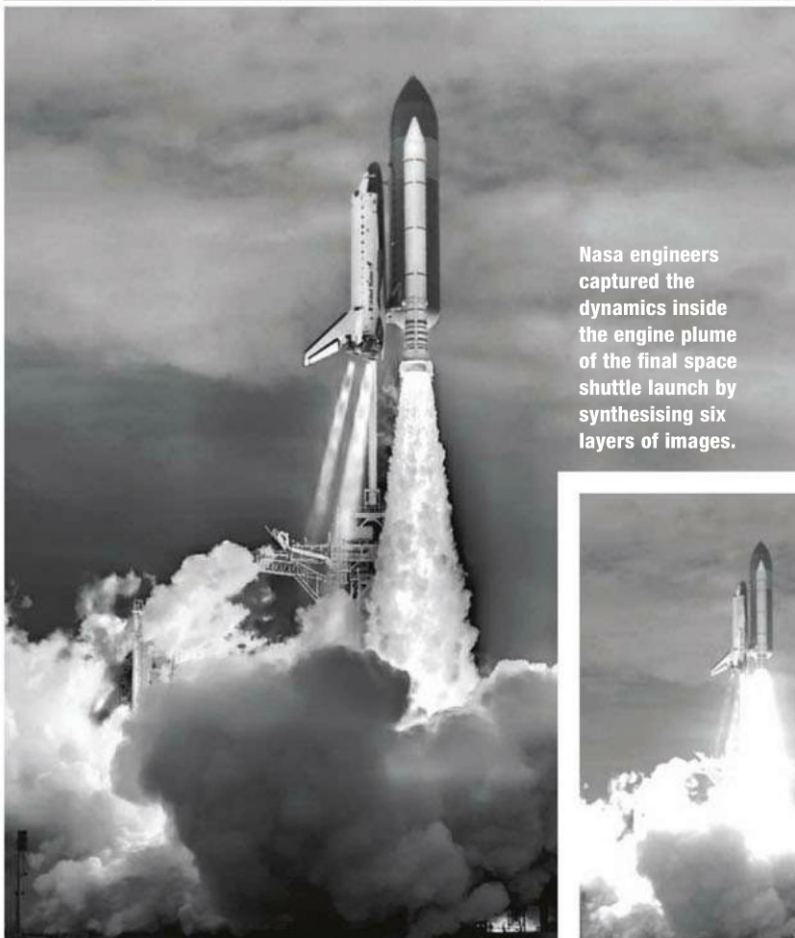
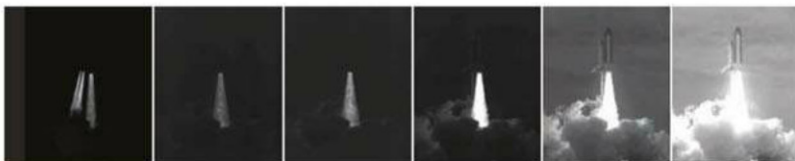
Multi-tool tails

Scientists have long known that viruses spread in an organism by injecting material into individual cells, using the host to replicate its own genetic material. But exactly how a virus invades and takes control has been a mystery – until now. Medical researchers in Japan have discovered that certain viruses use a protein on their tail as a multifunctional tool – the biochemical equivalent of a Swiss Army Knife – to penetrate cells. First, a virus rotates its screw-shaped tail like a drill bit, puncturing the cell's membrane. The tail then thrashes to clear away organic debris and enlarge the hole, allowing the virus to inject its own DNA or RNA. – ALEX HUTCHINSON



■ ROCKET SCIENCE

Blinded by the bright



Nasa engineers captured the dynamics inside the engine plume of the final space shuttle launch by synthesising six layers of images.

Rocket launches create a fiery spectacle, but they also create problems for Nasa engineers who want to see exactly what happens when the engines ignite. A complete view of a rocket exhaust provides details of thermal and physical dynamics that can be used to create high-fidelity computer models. The fury of blastoff, however, shrouds the scene in exceedingly bright flames and obscuring smoke.

Now, with a clever six-camera setup called Walle, Nasa has found a way to see into a rocket plume or any other brilliant blast. The system merges the clearest pixels of images taken by six cameras; the combined shots offer a superhuman view of the trickiest high-contrast scenes. Walle's creators at Nasa's Ames Research Centre built it from spare high-speed cameras. When Walle starts recording video, one camera properly exposes the dimmest parts of a scene, leaving the brighter parts blown-out white. The next camera uses a filter to capture brighter parts of the image the other camera couldn't. The remaining cameras use a series of increasingly dark filters until all bright and dark sections are properly exposed. Software then strips out the jet-black and

pure-white pixels in each of the six sets and fuses the correctly exposed portions into one shot.

But Walle is capable of much more than stunning visuals. It might also record high-contrast explosions to capture images of chunks of shrapnel inside the blast that are too dim for regular cameras to see. Another potential use: to record the exposure of materials to searing-hot plasma inside an arc jet, a device used to simulate the heat of atmospheric re-entry.

– DAVE MOSHER

VIDEO > Visit www.popularmechanics.co.za to watch a side-by-side comparison video showing a one-camera view of the STS-134 launch with the six-camera composite view.

EXPLORATION



Cady Coleman poses with her new space station crewmate: the first orbital android. Five cameras, one infrared, are mounted in the helmet.

Go up, young bot

Androids and spacecraft have been science-fiction staples for decades, but for the first time that pairing is being tested in orbit. The pioneering Robonaut 2 (aka R2) is aboard the

International Space Station, preparing to go to work – and to validate the idea that a humanoid robot can be an asset to a busy crew. Nasa and General Motors engineers designed the legless R2 to perform routine tasks – such as flipping switches, taking simple measurements and polishing handrails – so scientists have more time for substantive work. “If Robonaut can provide just an hour’s worth of relief to the crew, that would make the experiment worth it,” says deputy project manager Nic Radford. – *STEVE ROUSSEAU*

NOW

Getting acclimated

Before R2 gets to work, Nasa engineers calibrate its movements for a zero-g environment. “Now that you don’t have gravity, there is no weight on the arm,” Radford explains. “The robot moves with less effort.” The adjustments ensure, for example, that the R20 million R2 won’t punch a hole through an instrument panel while simply trying to push a button.

SOON

Learning on the job

R2 will be given a task by engineers, then decide for itself how to complete it. “It’s not an artificially intelligent robot, but it has the ability to do a task in an intelligent way,” Radford says. Using visual processors and more than 350 force and torque sensors, R2 will be able to detect if it has correctly responded to a command, such as flipping a switch or tightening a bolt.

FUTURE

Stretching its legs

On Earth, R2 weighs 150 kilograms, so it’s not a good idea to have it floating around a space station. Nasa plans to send the lower limbs to the ISS to enable the robot to grasp handrails and swing like a monkey moving through trees. Robonaut 2 will also be able to dodge obstacles. “It’ll say, Hey, something just floated by – I need to not run into it,” Radford says.

FUTURE RIDES

1. Intake

Air entering the inlet fills a small, high-pressure tube encircling the rim.

2. Big push

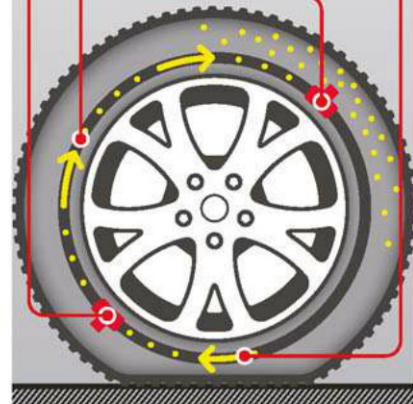
Air is forced through the inner tube by ground pressure on a low tyre.

3. Inflate

Tyre pressure returns to normal as air fills it through the outlet valve.

4. Vent

Excess air escapes through the inlet port.



THE SELF-INFLATING TYRE

Searching for the air hose in the grimmest corner of a neighbourhood service station may soon become a thing of the past. With the help of a 12 million US Department of Energy grant, Goodyear is developing a tyre that regulates its own air pressure. Though the company refused to leak details of how the system works, a 2009 patent application shows that the tyre employs a pressurised internal tube with inlet and outlet valves. This differs from the automatic inflation system on military vehicles that use on-board compressors. “The Air Maintenance Technology system is powered by the tyre itself as it rolls down the road,” says Goodyear chief technical officer, Jean-Claude Kihn. Under-inflation can lead to tyre failure and a possible crash, but in most cases it just wastes fuel. According to Goodyear, under-inflation cuts a car’s efficiency by 2,5 to 3,3 percent.

– *DAN CARNEY*

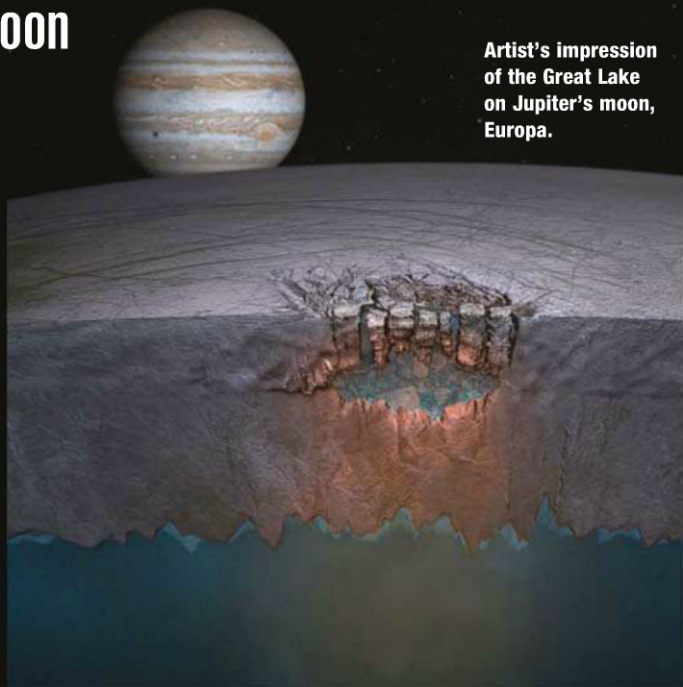
'Huge lake' found on Jovian moon

In a finding of significance in the search for life beyond Earth, scientists have discovered what appears to be a body of liquid water the volume of the North American Great Lakes locked inside the icy shell of Jupiter's moon, Europa – a finding that could represent a new potential habitat for life.

Many more such lakes exist throughout the shallow regions of Europa's shell, the researchers predict in an online article for the journal *Nature*. Further increasing the potential for life, many of these lakes are covered by floating ice shelves that seem to be collapsing, providing a mechanism for transferring nutrients and energy between the surface and a vast ocean already thought to exist below the thick ice shell.

"The potential for exchange of material between the surface and subsurface is a big key for astrobiology," says Wes Patterson, a planetary scientist at the Johns Hopkins University Applied Physics Laboratory, and a co-author of the study. "Europa's subsurface harbours much of what we believe is necessary for life..."

Source: Johns Hopkins University



Artist's impression of the Great Lake on Jupiter's moon, Europa.

Britney Schmidt/Dead Pixel FX/University of Texas at Austin

■ SINUSES COULD BE KEY

I'm not bored. My brain is hot

Yawning may no longer be a wide-open question. A new theory proposed by scientists Gary Hack of the University of Maryland School of Dentistry and Andrew Gallup of Princeton University suggests that yawning cools the brain, and that the sinuses may play a key role.

Writing in the journal *Medical Hypotheses*, Gallup and Hack tackle the question of why humans yawn, and explore the possible function of the human sinuses. Yawning occurs not because you are tired, bored, or even need oxygen, they argue. Instead, yawning helps to regulate the brain's temperature. "The brain is exquisitely sensitive to temperature changes and therefore must be protected from overheating," the scientists write. "Brains, like computers, operate best when they are cool."

The scientists propose that the walls of the human maxillary sinus (pictured in green) flex during yawning like a bellows, which in turn facilitates brain cooling. The theory helps explain the function of the human sinuses, which is still debated among scientists. In fact, says Hack, everything concerning the human sinuses is debated. "Very little is understood about them, and little is agreed upon even by those who investigate them. Some scientists believe that they have no function at all."

Beyond the physiological curiosity, the brain cooling theory of yawning also has practical medical implications. Bouts of excessive yawning often precede the onset of seizures in epileptic patients, and predict the onset of pain in people with migraine headaches, explains Gallup. Hack and Gallup predict that excessive yawning might be able to be used as a diagnostic tool in identifying dysfunction of temperature regulation.

Source: University of Maryland

PM



During a yawn, the walls of the human maxillary sinus (in green) flex like a bellows, which in turn facilitates brain cooling.

Lawrence M Witmer, Ohio University

X-PLANE

RISING



VIDEO

> Visit www.popularmechanics.co.za to watch the X-47B flight test highlights.



> BY JOE PAPPALARDO

X-47B

ALTITUDE: 12 000 M

AUTONOMOUS AERIAL REFUELLING PROBE & DROGUE

POWERPLANT: PRAIT & WHITNEY F100-PW-220U

TWO WEAPON BAYS:
4500-LB CAPACITY

MAXIMUM SPEED:
HIGH SUBSONIC

CREW: NONE

WINGSPAN: 18,9 M

LENGTH: 11,6 M

THE FUTURE OF
NAVAL AVIATION
MAY NOT BELONG
TO PILOTS. THE
PENTAGON IS
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OUT AN AVIATOR
OR REMOTE CONTROLS.
WILL UNMANNED
AIRCRAFT END THE
ERA OF TOPGUN?

For Ensign Kyndra Chitwood, learning how to fly blind is just part of becoming a US naval aviator. The 23-year-old strides across the flight line at Naval Air Station Whiting Field. Around her, dozens of orange and white T-34 Mentor training aircraft are lined up, fuselages gleaming in the Florida sun. Pairs of student-trainer teams in flightsuits are making their way to and from the aircraft. A formation flight of two T-34s cruises overhead, wingtip to wingtip.

Chitwood is readying herself for a tense afternoon in the air. A typical five-day week at Whiting, 40 kilometres northeast of Pensacola in the Florida panhandle, features daily flying tests; each is a high-pressure evaluation. Today Chitwood must prove she can pilot the T-34 using instruments alone.

Northrop Grumman is making the US Navy's newest experimental warplane, a carrier-ready unmanned aircraft called the X-47B, shown here during structural stress tests at the company's facilities in California.

Just after takeoff she will pull a nylon hood across half of the cockpit canopy to block her vision, then steer the single-engine prop plane through landing approaches at several civilian airfields. She will be asked to demonstrate her ability to use GPS signals, UHF transponders on the ground and radio commands from radar operators.

Within 40 minutes of suiting up, Chitwood and her instructor are cleared for takeoff. The aircraft buzzes down the runway and sails into the sky, banking toward Marianna Municipal Airport, 200 kilometres east. She would normally handle takeoff on her own, but the instrument tests require that she sit in the T-34's back seat, so her instructor guides the aircraft into the air.

The clouds are so thick she can't see the horizon, so there's no need to pull the hood closed. Once her instructor removes his hands from the controls, the day's aerial evaluation will begin.

Primary flight instruction here is the start of a process that makes US naval pilots the best in the world. Every student in the class is graded on a bell curve, and those who score highest usually get first choice of flight assignments.

These aviators are jockeying against one another for seats in cockpits, but the generation of naval pilots after Chitwood may be grounded by new competition: robots. The Navy is aggressively researching the use of unmanned aerial vehicles (UAVs) for jobs now performed by people. By the time a pilot like Chitwood retires in 2030, assuming a full career, there could be a lot fewer aircraft for her replacement to fly.

DOGFIGHT FOR THE FUTURE

Strike fighters are the teeth of an aircraft carrier, protecting the ship from aerial threats and attacking targets on the ground. The idea that UAVs can perform these missions is heretical to officials who say that a carrier deck is too complex for an unmanned aircraft. But the orthodoxy is changing, and two naval aircraft are now vying for future dominance.

In one corner, there's the US Navy's marquee future warplane, the F-35C Lightning II. A product of the Joint Strike Fighter programme, the F-35C will be the US Navy's first stealth aircraft. At a little over R1 billion per aeroplane, it is the most expensive defence programme in the world.

The JSF programme started in 1996; five years later, Lockheed Martin beat Boeing for the multibillion-rand contract. The programme is producing three F-35 variants: one for the Navy, another for the Air Force and a short-takeoff and vertical-landing version for the Marine Corps. Each aircraft is now nearing the end of a tortured development – years late and tens of billions of rand over budget.

In the opposing corner is the X-47B, an experimental airplane with something to prove. Even though it's just a demonstrator, it has folding wings that enable it to fit

inside a carrier's hangar, twin weapons bays and the ability to fly at high subsonic speeds. The programme started in 2000 as one of two R16 million concept studies, but the UAV is no longer a line-item underdog.

The X-47B is a testbed supporting the R20 billion Unmanned Carrier Launched Airborne Surveillance and Strike programme. UCLASS may result in an unmanned aircraft that can perform the same missions as the F-35C but would stay in the air longer and be harder to spot on radar.

'MY THINKING IS THAT [UAV ADOPTION] IS TOO DAMN SLOW. WE'VE GOT TO HAVE A SENSE OF URGENCY ABOUT GETTING THIS STUFF OUT THERE.'

**ADMIRAL GARY ROUGHEAD,
CHIEF OF NAVAL OPERATIONS**

When he was selected to head the X-47B programme in late 2010, Captain Jaime Engdahl thought the UAVs would be remotely piloted to the deck with a joystick. "I didn't even realise, until I really started digging, how advanced some of the things that we're doing are," he says. "This is, no kidding, making an air vehicle that's autonomous and as self-sufficient as a naval aviator."

A few years ago, predictions that the F-35C would be the last piloted Navy fighter seemed overly dramatic. But as the X-47B progresses, the prediction is more realistic. The Navy will not deploy the F-35C on a carrier until late 2016. The Pentagon plans to integrate strike UAVs into the fleet by 2018.

Despite stalwart support from Navy brass, politicians are considering trimming the F-35C and other JSF variants: in 2010, a fiscal commission recommended halving orders of F-35Cs.

There are signs that the budget crisis may change the landscape within the Navy. Aviation Week obtained a 2011 memo from US Navy Undersecretary Robert Work asking Navy brass to seek alternatives to the F-35C. (He also asked the Marine Corps to examine the impact of eliminating the problematic F-35B.) The response will be ready for the 2013 budget.

The Navy's need for the F-35C and the new UAVs is based on the emergence of fresh threats. Any future strike aircraft needs to be stealthy – advanced radar and anti-aircraft missiles make strike and surveillance missions dangerous.

There are other threats that will likely force carriers to operate at greater distances from targets. China is fielding submarines that can lurk in the shallows, where side-scan sonar is



Ensign Kyndra Chitwood doesn't believe her career as a Navy pilot is threatened by unmanned aircraft. "It's hard to integrate them into the fleet," she says.

THE
CONTENDERS

High-performance strike airplanes are the A-list celebrities of the US Navy. These warplanes must be tough enough to handle the stress of catapult launches, sophisticated enough to evade electronic attack, rugged enough to withstand salty ocean air, nimble enough to dogfight a MiG and deadly enough to eliminate ground targets with precision. Four warplanes fit these criteria; all are vying for primacy as the Navy reshapes its future.

**NAME** Phantom Ray**MANUFACTURER** Boeing**SELLING POINT**

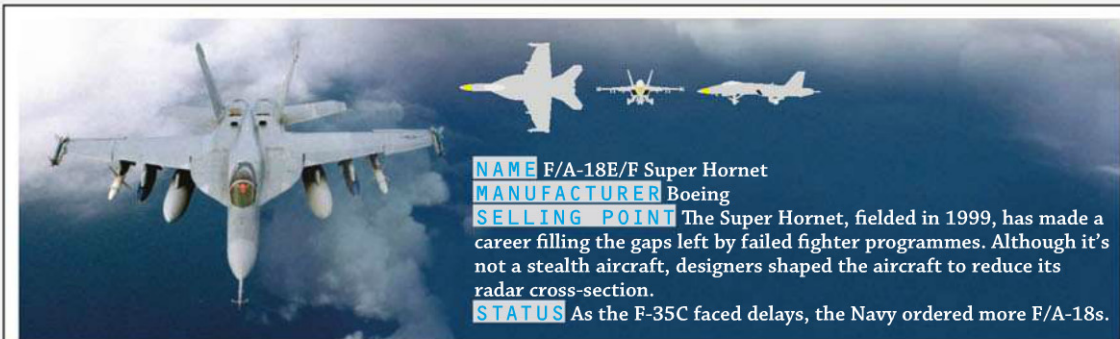
The company completed its first experimental stealth UAV, the X-45A, in 2000 and sporadically improved the prototype.

STATUS In 2011, Boeing paid for Phantom Ray test flights, positioning itself for a pending Navy strike-aircraft competition.

**NAME** F-35C Lightning II**MANUFACTURER** Lockheed Martin

SELLING POINT The F-35C, the carrier variant of the Joint Strike Fighter, is the most sophisticated warplane ever built. Pilots will be able to see threats from 360 degrees and access targeting data from other aircraft and ground sensors.

STATUS After years of delays, the F-35C may deploy in 2016. The US Congress is considering cutting the number of planes it orders.

**NAME** F/A-18E/F Super Hornet**MANUFACTURER** Boeing

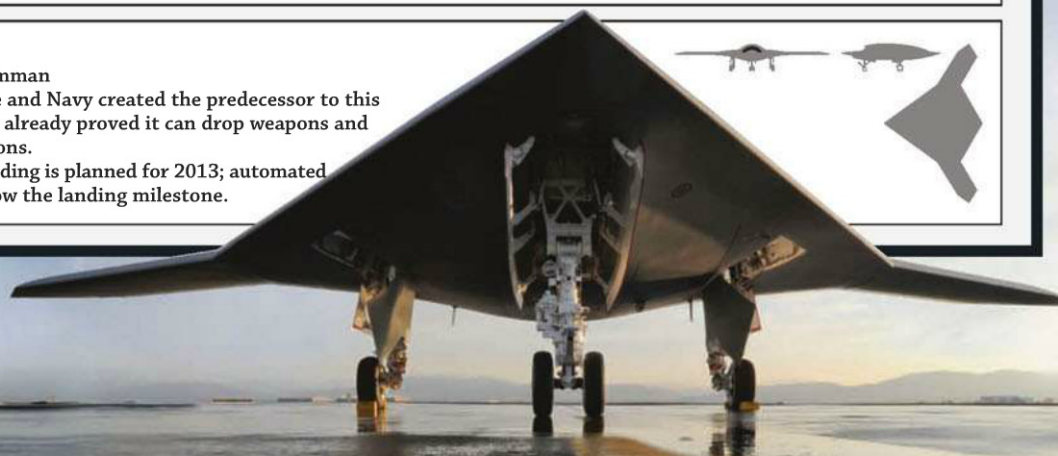
SELLING POINT The Super Hornet, fielded in 1999, has made a career filling the gaps left by failed fighter programmes. Although it's not a stealth aircraft, designers shaped the aircraft to reduce its radar cross-section.

STATUS As the F-35C faced delays, the Navy ordered more F/A-18s.

NAME X-47B**MANUFACTURER** Northrop Grumman

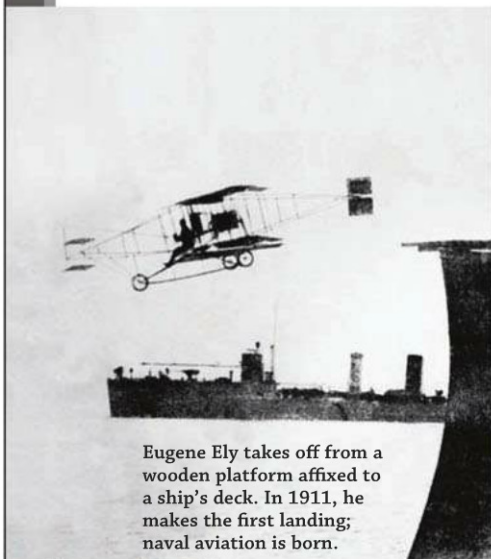
SELLING POINT The Air Force and Navy created the predecessor to this demonstrator, and that version has already proved it can drop weapons and autonomously fly preplanned missions.

STATUS The UAV's first carrier landing is planned for 2013; automated aerial refuelling tests will soon follow the landing milestone.



WARPLANES AND WARSHIPS

A 100-YEAR RELATIONSHIP



Eugene Ely takes off from a wooden platform affixed to a ship's deck. In 1911, he makes the first landing; naval aviation is born.



Lieutenant Virgil Griffin, in a Vought VE-7SF biplane, becomes the first to fly from the US Navy's first aircraft carrier, the USS Langley.

The Navy defeats the Japanese in the decisive Battle of Midway. Carrier-based American warplanes sink five Japanese warships; the US loses a carrier and a destroyer.

POPULAR MECHANICS reported in 1914 that the British were constructing ships built specifically to accommodate aircraft and designing these "flying boats" with folding wings so they could be more easily stowed at sea. From these humble beginnings, naval aviation has come to dominate global affairs. The ability to protect allies and interests around the globe depends on delivering air power quickly and without reliance on airfields. The missions of naval aviators go beyond airstrikes; helicopter pilots hunt submarines, prop planes gather intelligence and jets protect troops on the ground. It's been a busy 100 years; below are a few highlights.

During the Vietnam War, US aviators in Navy F-4s shoot down 24 enemy MiGs in 1972 alone.



Instead of supporting fleet operations, naval aviators during the Korean War (1950-53) dedicate the majority of their flights to supporting ground forces. Their contribution is large: on the last day of the war, 21 squadrons fly missions from four aircraft carriers.

1910

1922

1942

1953

1972

Since the 1980s, the combat radius* of Navy warplanes has declined, largely in part because of heavier payloads of weapons and advanced sensors. Midair refuelling aircraft can extend missions, but most refuellers are based on land and vulnerable to attack. New technology has increased the combat radius of naval aircraft; unmanned strike aircraft are expected to triple the fighting range of an F-14 Tomcat.

* INFLUENCED BY ALTITUDE AND MISSION PROFILE

F6F-5 Hellcat
Deployed: 1943
Bomb load: 230 kg

F-14 Tomcat
Deployed: 1974
Bomb load: 6 800 kg

CARRIER

Combat radius: 600 km
(drop tank only)

900 km

less effective. These quiet subs are armed with sea-skimming missiles that can slip past a ship's defences. The Russians build and sell sophisticated warplanes that can venture from air bases on land to swarm a carrier and its escorts with air-to-ship missiles.

The emergence of these close-to-shore threats is bad news for the US Navy because the reach of its strike aircraft has been decreasing since the 1980s. The F-35C's 1 000-kilometre combat radius will reverse the trend, but UAVs such as the X-47B easily double that distance.

And there's another metric to consider: the amount of time a stealth warplane can linger over a target. The military calls this attribute persistence. A manned aircraft's persistence is limited by the endurance of the human onboard. A weaponised UAV, on the other hand, can track a target for dozens of hours in protected airspace and then drop a precision weapon on command.

"My thinking is that (UAV adoption) is too damn slow," said

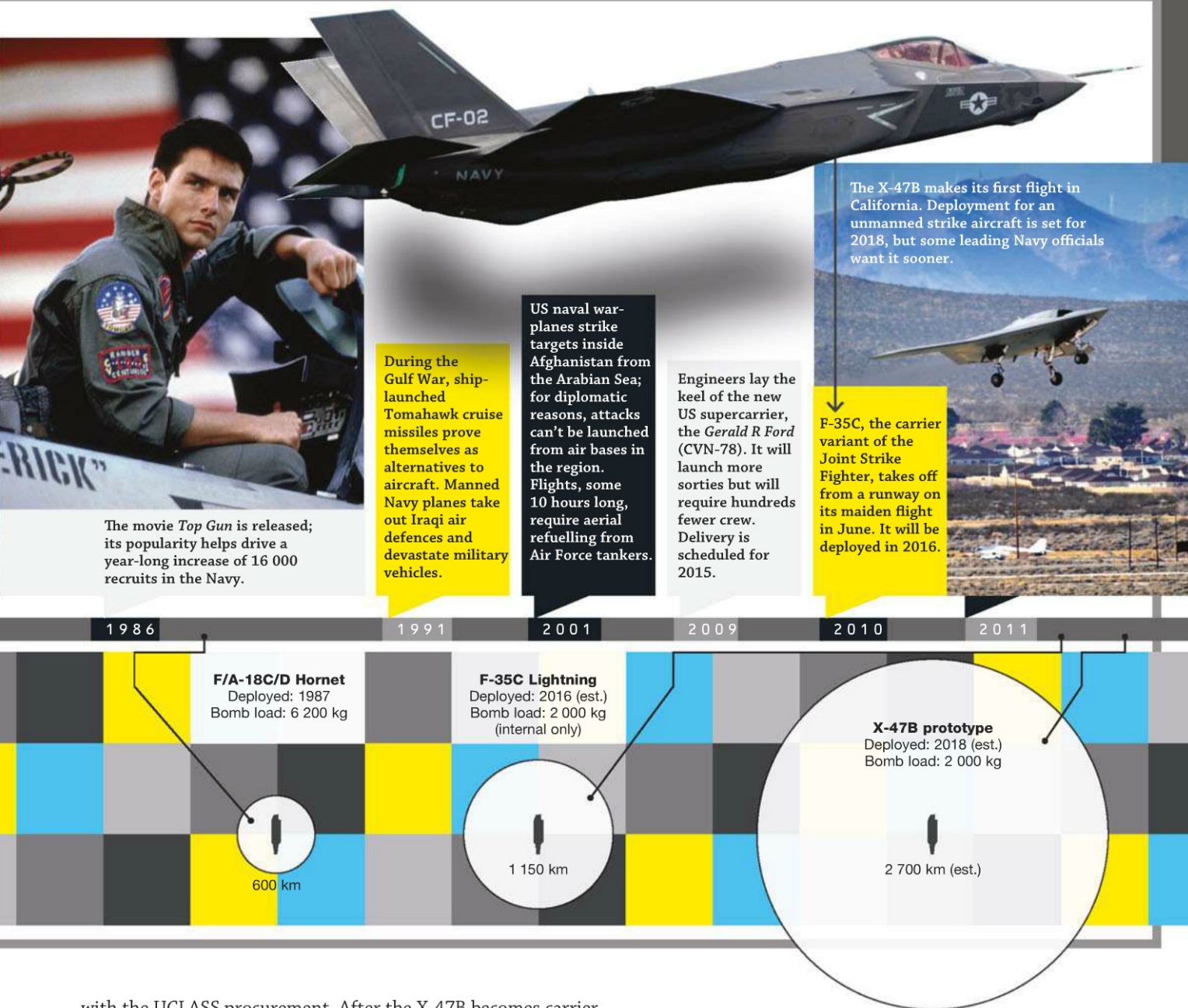
Admiral Gary Roughead, the chief of naval operations, during a speech in August. "We've got to have a sense of urgency about getting this stuff out there."

WHERE ROBOTS GET THEIR WINGS

This July, Lieutenant Jeremy DeBons made aviation history by doing nothing at all. DeBons, call sign Silas, flew a one-of-a-kind F/A-18D through the vast Atlantic test range off the coast of Virginia. His destination: the aircraft carrier USS *Eisenhower*. The F/A-18D and the carrier were loaded with a slew of sensors that enabled the warplane to land on the carrier's deck without any piloting from the cockpit or remote operation by the ship's crew.

The F/A-18D was a surrogate for the X-47B demonstration aircraft. The goal of the summer tests was to prove that the brains of a robot can guide a warplane to a carrier's pitching deck. If this demonstration programme succeeds, the Navy can proceed

Photograph by Getty Images (1910), US Dept of Defence



with the UCLASS procurement. After the X-47B becomes carrier-ready, it will then autonomously rendezvous with aerial refuelling tankers.

Future unmanned aircraft will not be flown by crews via joystick, as Air Force personnel currently operate MQ-1B Predators. Once launched, a UAV following a prearranged mission plan will use onboard sensors to avoid other aircraft and dodge enemy attacks. It will also identify targets in the air and on the ground and track them without direct command. (These UAVs will contact controllers for permission to release weapons.)

Landing on an aircraft carrier is one of the most difficult feats of aviation, requiring a clever mesh of man and machine. The Navy is building the X-47B's landing capability on technology pilots use today, the Precision Approach Landing System. PALS uses SPN-46 radar to locate an aircraft in relation to a carrier.

To perform the occasional hands-off landing, such as when

weather obscures the ship, an F/A-18 pilot can couple the plane's autopilot with PALS data. But the PALS radar covers only the rear of the carrier and is limited by the number of aircraft it can track simultaneously. These deficiencies make it unsuitable for controlling UAVs that are approaching to land.

Instead, the Navy's robotic landing system relies on precise GPS co-ordinates to obtain 360-degree coverage and automate navigation. The aircraft calculates the appropriate flight paths around the ship as the carrier supplies the vessel's speed, the sea state and other data.

The concept behind the X-47B is to replace pilots – but not a ship's crew. As with other carrier-borne aircraft, the final approach of the unmanned vehicle would be monitored by the personnel onboard. Officers on the flight deck, the air traffic

controller seated under the deck and officers peering from windows in the carrier's island all play a part in guiding the UAV.

Pilots most often talk with the ship by radio, but for a UAV verbal communication is replaced by digital commands. The carrier's air traffic controllers do the same job as an ATC crew in a civilian airport tower – if the runway were constantly changing location, the aircraft loaded with live weapons, and the process designed to produce as few electromagnetic emissions as possible to avoid detection.

"There's no benefit in changing the way we do deck handling," says Adam Anderson, who heads the carrier integration portion of the X-47B programme. "We're looking at ways to make the least amount of impact. We want a paradigm shift in the number of missions the aircraft can do, but to have no shift in the way it lands."

DeBons's test flights on the *Eisenhower* went perfectly – the F/A-18D glided across the deck with its nose angled up until a hook on its tail snagged a cable stretched across the deck and jerked the aircraft to a halt. Still, the Navy test pilot says his hands never strayed too far from the controls.

"It wasn't anything new, perspective-wise, in the cockpit," DeBons told reporters after the flight. "But being a new system, as any test pilot will say, we're always on guard."

HUMAN/UAV COEXISTENCE?

The X-47B's next big milestone is a series of aircraft carrier launches and landings in 2013. That is the same year that the F-35C will operate for the first time on a carrier, making its initial sea trials.

A technology demonstrator is a long way from a production-ready warplane like the F-35C. Even the most gung-ho Navy official extolling UAVs also expresses support for the Lightning II. "As rapidly as we want to engage with the unmanned systems on carriers, we are also moving forward with an incredible capability in the Joint Strike Fighter," Roughead says. "We've got to get that aircraft."

The pilot is the F-35C's main limitation, but the human being in the cockpit may also be its salvation. The F-35C is designed to accommodate and enhance the most powerful processor available – the human brain. The aircraft's external sensors are patched directly into the pilot's helmet, allowing him to see 360 degrees by synthesising data from the sensors, including six infrared cameras and radar. In short, there has never been a better aircraft for picking targets and seeing threats.

"Target recognition often involves the generation and interpretation of high-resolution images," Owen Cote Jr, the associate director of MIT's Security Studies Programme, wrote in a recent report. "At some point in the future it may become possible to automate that process, but today, and for a number of years, target recognition will require people to interpret the images... It is difficult to imagine automating this."

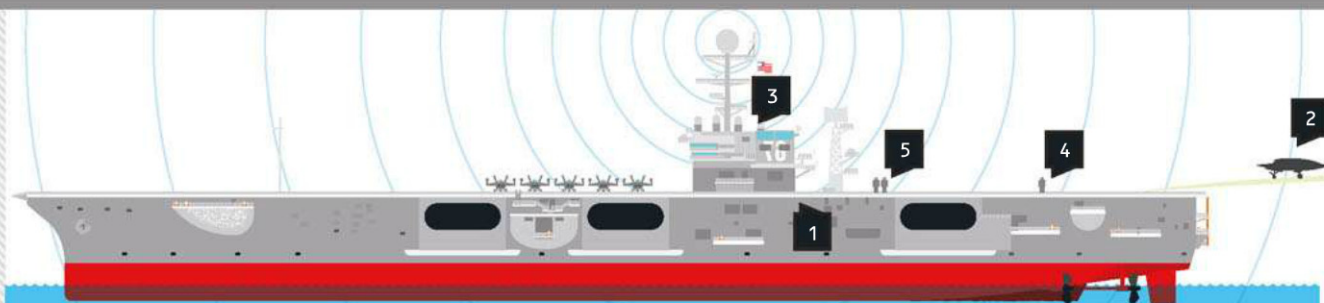
Others caution putting too much faith in stealthy UAVs as a solution to every tactical and budgetary problem at the Pentagon. "If you cancelled the F-35 you would have to do something else," says Douglas Barrie, military aerospace senior fellow at the International Institute for Strategic Studies. "Do you kick off a whole new development programme with all the inherent risks and costs that you've just gone through with the F-35?"

It appears that the Navy's near future will focus on human-robot teaming. The F-35C and UCLASS will operate from carriers

HOW IT WORKS

UNMANNED AIRCRAFT TRAPS

Navy robotic aircraft will operate autonomously, but they will still require people onboard to land. "Carrier naval aviation is extremely safe for the level of risk," says retired Rear-Admiral Craig Steidle, the former head of the Joint Strike Fighter and F/A-18 programmes. "The Navy is slow to evolve, which is fortunate because we have a very safe and effective system."



1 At 90 kilometres, the unmanned aerial vehicle enters carrier-controlled airspace and uploads its location and fuel status to the carrier. Personnel in the Carrier Air Traffic Control Centre (CATCC) decide the landing order of the waiting planes based on fuel levels.

2 The UAV doesn't break its holding pattern until the CATCC gives permission. It will approach and land autonomously using a ship-relative GPS-based landing system.

3 From a perch in Primary Flight Control in the carrier's island, the air officer (or air boss) maintains visual control of all aircraft operating within 5 nautical miles (9 km).

4 The final approach is monitored by the landing signal officer. In an emergency, the LSO can "wave off" the craft with a digital command from a handheld device. If waved off, the UAV adds power and climbs to 200 metres to wait for instruction.

5 Once the unmanned aircraft lands, deck handlers guide it with commands from a hand controller.



simultaneously and fly missions next to each other in tomorrow's conflicts. "No platform fights alone anymore," says Edward Timperlake, a former analyst of emerging technology for the office of the US secretary of defence. "It's a synergy between manned and unmanned."

But, as time goes on, UAVs will become more capable and the ratio of manned to unmanned missions could dramatically shift in favour of the machines. "The era of manned airplanes should be seen as over," the Brookings Institution's Michael O'Hanlon says, echoing other military analysts.

Few young pilots see a threat looming. After all, the number of people the Navy needs to fly is holding steady. The students at Naval Air Station Whiting Field say their careers remain unclouded by robotic competition.

"I don't see anyone concerned about the community shrinking," says Lieutenant (junior grade) Bobby Lennon, who finished

training at Whiting in August and will fly an MH-60S Knight-hawk helicopter. "Maybe this will affect the jet guys more."

But the Navy's effort goes beyond the X-47B. The service is investing more than R60 billion over the next five years in a family of unmanned UAVs. For example, the Navy plans to retire fixed-wing EP-3 Aries signals intelligence reconnaissance planes and replace them with unmanned aircraft by 2020. The Navy is already operating unmanned reconnaissance helicopters – one was shot down during combat operations in Libya – and it is constructing larger ones to carry cargo and arming others with air-to-surface missiles.

Chitwood, who aced her instrument flight examination over Marianna Municipal and Tallahassee Regional airports, is also unfazed by the emergence of UAVs. "I'm not really worried," she says. "It's hard to integrate them into the fleet. Maybe when I'm close to being done flying I'll see the effect."

It doesn't seem fair to bring up the US Navy's unmanned programmes when face to face with young aviators. That's policy talk, and every new Navy pilot is solely focused on the work. For them, earning the right to do the job is the only tomorrow that matters.

PM

Additional reporting by Sharon Weinberger



Whether it succeeds or fails, the X-47B will earn a unique place in aviation history. It either will be the first strike UAV to operate from a carrier deck or, by failing, will push the momentum back to manned Navy warplanes.

CHAT OR PLAY – YOU CHOOSE →

Torn between getting a funky new smartphone or cool handheld gaming device? Don't sweat. What you need is Sony Ericsson's Xperia Play. This nifty handset combines all the features you'd expect from a smartphone and a slide-out PlayStation-certified gaming pad.

On the gaming front you get a digital D pad, two analogue touch pads, two shoulder buttons and the four PlayStation icons: circle, cross, square and triangle. Qualcomm's optimised Snapdragon processor with a 1 GHz CPU and embedded Adreno GPU graphics processor delivers smooth 60 fps playback 3D mobile gaming and Web browsing with minimal power consumption. A pre-loaded app enables users to easily discover and download titles that have been optimised for game play on the Xperia. Price: about R5 100. Visit www.sonyericsson.com



STORE AND GO →

Looking for a durable USB flash drive with a decent storage capacity? Then you'd better check out Kingston's DataTraveler R400. Apart from being capable of storing a whopping 32 GB of data (think plenty of high-resolution photos, graphics-intensive documents, videos and the like), it also boasts a read speed of 25 MB/s and write speed of 10 MB/s. Its rubberised casing keeps the drive nice and safe while you're getting on with life. It comes with a five-year warranty and live 24/7 tech support. Price: about R500. Contact distributor Axiz on 011-237 7228 or visit www.kingston.com/saroot



WATCH WHAT YOU USE

Thanks to escalating electricity prices, managing our consumption levels has never been more critical. The obvious answer is an affordable monitoring system that allows you to identify the "power hogs" around your home. Powertime has two monitors, the entry-level TREC and more sophisticated ENVIR, which have been customised to display electricity consumption in a way we all understand – in rand.

Both devices connect wirelessly to a sensor on the electricity utility incoming cable, allowing the monitoring unit to be placed conveniently anywhere in the house. The TREC displays your consumption in real time, while the ENVIR allows users to compare consumption graphically with previous days and months. It also stores your energy data and can export it to your computer via USB cable or the Internet. Expect to pay about R700 for the TREC and R1 400 for the ENVIR. Visit www.powertimestore.co.za



GAME CHANGER →

If you thought GoPro's original HD Hero was the ultimate action sports camera, think again. The company's upgraded version, the HD Hero2, is streets ahead of its now antiquated sibling. Virtually everything about it has been improved. A new processor delivers twice the processing power, taking full advantage of the new high-performance 11 MP sensor, which is capable of more than double the image detail and low light performance. The totally redesigned wide-angle lens is twice as sharp as the previous model. And, with the arrival of GoPro's new Wi-Fi BacPac and Wi-Fi remote, it can be controlled remotely either via the remote, smartphones, tablets or computers. Plus, it can broadcast live video feed via Wi-Fi or mobile hotspots.

Other cool features include a more intuitive user interface, 3,5 mm stereo external microphone input, and four red LED indicators (one for each side of the body) so you can now easily see when it's recording. Price: about R4 000 (for any one of the three basic packages: the Outdoor, Motorsport and Surf Editions). Contact GoPro SA on 021-691 0110 or visit www.gopro.com



✓
Editor's
choice





PLAY LIKE A PRO ↑

Upping your golf game can take years of frustrated dedication, especially if you don't have Garmin's new golf-dedicated GPS, the Approach G5. This rugged waterproof device features a high-sensitivity GPS receiver that measures individual shot distances and shows the exact yardage to fairways, hazards and greens, thus removing the guesswork from your game. It comes with over 180 pre-loaded South African courses – and thousands of European courses, too.

The sunlight-readable touch-screen makes using it as easy as downing a cold one at the 19th. A simple tap and drag allows you to move the flag location on the green for precise distances to the day's pin locations. A tap anywhere on the hole (on the screen, that is) gives you precise distances to unlimited landing areas. It also doubles up as a digital scorecard for your foursome, and after the game you can save and review the scores on your computer at home. Price: about R4 400. Contact Garmin on 0861 427 646 or visit www.garmin.co.za



HAPPY SNAPPER ↑

Just because you're not a trained photographer doesn't mean that you're doomed to take lousy photos. Olympus' latest ultra-zoom camera, the 14-megapixel SP-810UZ, makes capturing great shots a breeze. By doing away with time-consuming manual settings, it allows you to concentrate on the essentials. Intelligent Auto mode recognises the five most common photo scenarios and automatically optimises settings such as focus and lighting. Just to make sure that everyone you shoot looks great, its Beauty mode hides unwanted blemishes. There's a Pet Detection mode for automatically capturing Rover's face when he looks at the camera.

Its 36x wide optical zoom (24 – 864 mm 35 mm camera equivalent) allows you to get up close and personal, and dual image stabilisation reduces blur in fast-moving subjects. HD (720p) movie capture with sound allows you to record special moments. And 10 "magic" filters let you create some cool effects when shooting video or stills. Price: about R3 800. Contact distributors Tudortech on 021-424 2978 or visit www.olympus.co.za

ULTIMATE SURVIVOR ↓

Whereas communing with Nature is generally about shedding accumulated stress and breathing fresh air, exploring the great outdoors can occasionally land you in stressful situations. When the proverbial smelly stuff hits the fan, you'd better hope that you have the Bear Grylls Ultimate knife with you. Designed with serious survival and adventure in mind, its blade is big enough to be used as a chopping device, but sufficiently compact to allow for precise cutting and shaving movements. Features include a stainless steel pommel at the base of the knife (for hammering tasks), an emergency whistle integrated into the lanyard cord, and a blade sharpener in the knife sheath. It also comes with a fire starter (ferrocium rod). Price: about R900. Contact Cape Union Mart on 0860 034 000 or visit www.capeunionmart.co.za



All a man needs

From new and affordable Internet packages to the convenience of loading airtime onto your phone with Internet bundles, MTN is making sure you start the year on a high!

The beginning of the year brings its fair share of excitement, planning and resolutions – one of which is surely to keep a check on the budget for the whole year, not just January! With MTN's uncapped Internet packages, you're off to a great start, without having to reduce the time you spend online.

Here's how:

- With MTN you can enjoy lower rates and fast Internet access with MTN Uncapped Lite or Uncapped Pro, both available on a 24-month contract, for much less.
- With MTN Uncapped Internet you can stay online, browse the Internet and download as much as you like for a fixed monthly price.

MTN Contract Packages

MTN Internet bundles	Monthly subscription	Includes
MTN Uncapped Lite	R289	Modem or Router
MTN Uncapped Pro	R879	Modem or Router

* From 1 February 2012 a fair-use limit will apply. Once the 3GB (Uncapped Lite) and/or 10GB (Uncapped Pro) fair-use limit has been reached, the maximum connection speed will be limited up to 256 Kbps for the user for the remainder of the month. Both packages are available on 24-month contracts.

Please note: during a promotional period (lasting till 31 January 2012), new and existing MTN Uncapped Internet customers will have uncapped Internet on their laptops, tablets or any Internet-capable device. MTN Uncapped Lite and Pro are ordinarily subject to a fair-use policy. If you reach our fair-use amount, you can still use the Internet for the things you love most – like email, Facebook and news sites – and we won't charge you any extra. A fair-use policy will again be applied to MTN Uncapped Internet packages at the end of this promotion on 1 February 2012.

Both MTN Uncapped Lite and Pro packages come with the MTN Sh@relink WiFi Internet router which means multiple devices can be connected to the Internet at the same time. Perfect if you're running your own business, and a great saving for the family at home. This router is included in the monthly subscription fee.

And getting Internet on the go is easy with MTN's F@stLink E376, also available on MTN Uncapped Lite for R289 per month.

If you are a PayAsYouGo or contract customer and would like to make use of low-cost Internet, whilst capping the costs of your



Opera Mini browser

For cheaper and faster Internet on your cellphone, install MTN Opera Mini browser at <http://m.opera.com>.

monthly data bill, then MTN Internet bundles are ideal for you. These bundles have been designed to reduce the cost of Internet usage provided you stay within the bundle limits. You can dial *141*6# to buy an Internet bundle on your phone.



For more information, visit www.mtn.co.za or visit your nearest MTN store



everywhere you go

CUT IN THE SUN →

Wilting under the hot summer sun just because you need to mow your lawn is for the birds. We'd much rather recline next to the pool with a cold one, and let Husqvarna's latest robotic wonder – the Automower Solar Hybrid electric mower – do all the sweaty work.

Suitable for lawns up to 2 200 square metres in size, it features a rechargeable NiMH battery and integrated solar panel to ensure it keeps getting the job done. And, when it needs more juice than the sun or battery can provide, it finds its own way back to its docking station for a much-needed recharge.

A settings menu allows you to program the mower to accommodate various lawns and preferences. There's also a timer, so you can decide if you want it to mow all day long, seven days a week – or not. Its electric motor produces very little noise (64 dB), so it'll never disturb an indulgent afternoon nap. Speaking of which, an integrated alarm will cry foul should anybody try to nick the Automower while you're otherwise engaged. Price: about R24 000. Visit www.husqvarna.co.za





BLAZE AWAY ↑

Fiddling with firelighters and the like to get your braai or fireplace going can be a drag. Come to think of it, so can waiting around for your coals to become just right before fetching the meat from the kitchen. The Looftlighter – a mains-powered device that uses superheated (600 degrees) air to ignite charcoal and wood – not only makes starting fires a breeze, but also dramatically speeds up the combustion process.

To give you an idea, if you want your charcoal to be ready after 30 minutes, you'll need to use the Looftlighter for only about one minute. On the other hand, if you want your fire to be ready for cooking as soon as possible, use it for about five to six minutes and you'll be braaiing in no time at all. Oh yes, it also comes with another handy feature – an integrated bottle opener, which makes perfect sense. Price: about R550. Looftlighter SA on 021-880 0074 or visit www.looftlighter.co.za



TAKE NOTE



Still relying on old-fashioned pen and paper to jot down reminder notes, doodle while on the phone or draw up cunning plans for world domination? If so, then you're hopelessly behind the times. The Boogie Board paperless LCD writing tablet facilitates all the above and more, but without any of us having to destroy trees in the process. Measuring 22 x 14 x 0,6 cm thick, it provides about the same writing space as half a sheet of letter-sized paper. Its pressure-sensitive surface allows you to draw lines of various thicknesses. And when it's time to clear the screen, a simple touch of the erase button does the trick. Powered by a small watch battery, it's said to last for approximately 50 000 erasures (or about 6 years if the screen is erased 20 times a day). Price: about R700. Contact Mantality on 011-462 5482 or visit www.mantality.co.za



GET WITH THE BEAT ↑

Budding drummers wanting to hone their anarchistic talent should seriously consider the Ion Discover Drums table-top drum set. The four drum pads provide 26 different drum sets, so you can play all kinds of musical styles. A built-in learning feature includes a follow-the-lights exercise to make things really easy, even if you've never played before. You can also irritate your family or neighbours no end by rocking it out loud via its built-in speaker; when you're feeling considerate, plug in your favourite headset. Price: about R850. Contact The Gadget Shop on 012-346 2726 or visit www.thegadgetshop.co.za

PM

The background of the entire page is black, adorned with several large, semi-transparent circles in various colors including light blue, green, purple, pink, and orange. These circles are of different sizes and are scattered across the page, creating a cosmic or abstract feel.

Does **THE** **MULTIVERSE** *really exist?*

Proof of parallel universes radically different from our own may still lie beyond the domain of science.

By George Ellis

IN BRIEF

The notion of parallel universes leapt out of the pages of fiction into scientific journals in the 1990s. Many scientists claim that megamillions of other universes, each with its own laws of physics, lie out there, beyond our visual horizon. They are collectively known as the multiverse. The trouble is that no possible astronomical observations can ever see those other universes. The arguments are indirect at best. And even if the multiverse exists, it leaves the deep mysteries of Nature unexplained.

In the past decade, an extraordinary claim has captivated cosmologists: that the expanding Universe we see around us is not the only one; that billions of other universes are out there, too. There is not one universe – there is a multiverse. In magazine articles and books such as Brian Greene’s latest, *The Hidden Reality*, leading scientists have spoken of a super-Copernican revolution. In this view, not only is our planet one among many, but even our entire Universe is insignificant on the cosmic scale of things. It is just one of countless universes, each doing its own thing.

The word “multiverse” has different meanings. Astronomers are able to see out to a distance of about 42 billion light-years, our cosmic visual horizon. We have no reason to suspect the Universe stops there. Beyond it could be many – even infinitely many – domains much like the one we see. Each has a different initial distribution of matter, but the same laws of physics operate in all. Nearly all cosmologists today (including me) accept this type of multiverse, which Max Tegmark calls “level 1”. Yet some go further. They suggest completely different kinds of universes, with different physics, different histories,

maybe different numbers of spatial dimensions.

Most will be sterile, although some will be teeming with life. A chief proponent of this “level 2” multiverse is Alexander Vilenkin, who paints a dramatic picture of an infinite set of universes with an infinite number of galaxies, an infinite number of planets and an infinite number of people with your name who are reading this article.

Similar claims have been made since antiquity by many cultures. What is new is the assertion that the multiverse is a scientific theory, with all that implies about being mathematically rigorous and experimentally testable. I am sceptical about this claim. I do not believe the existence of those other universes has been proved – or ever could be. Proponents of the multiverse, as well as greatly enlarging our conception of physical reality, are implicitly redefining what is meant by “science”.

OVER THE HORIZON

Those who subscribe to a broad conception of the multiverse have various proposals as to how such a proliferation of universes might arise and where they would all reside

George Ellis is a cosmologist and emeritus mathematics professor at the University of Cape Town. He is one of the world’s leading experts on Einstein’s general theory of relativity and co-author, with Stephen Hawking, of the seminal book *The Large Scale Structure of Space-Time* (Cambridge University Press, 1975).



THE PERILS OF EXTRAPOLATION

WHAT LIES BEYOND?

When astronomers peer into the Universe, they see out to a distance of about 42 billion light-years, our cosmic horizon, which represents how far light has been able to travel since the Big Bang (as well as how much the Universe has expanded in size since then). Assuming that space does not just stop there and may well be infinitely big, cosmologists make educated guesses as to what the rest of it looks like.

Level 1 multiverse: plausible. The most straightforward assumption is that our volume of space is a representative sample of the whole. Distant alien beings see different volumes, but all of these look basically alike, apart from random variations in the distribution of matter. Together, these regions, seen and unseen, form a basic type of multiverse.

Level 2 multiverse: questionable. Many cosmologists go further and speculate that, sufficiently far away, things look quite different from what we see. Our environs may be one of many bubbles floating in an otherwise empty background. The laws of physics would differ from bubble to bubble, leading to an almost inconceivable variety of outcomes. Those other bubbles may be impossible to observe even in principle. The author and other sceptics feel dubious about this type of multiverse.



They might be sitting in regions of space far beyond our own, as envisaged by the chaotic inflation model of Alan H Guth, Andrei Linde and others. They might exist at different epochs of time, as proposed in the cyclic universe model of Paul J Steinhardt and Neil Turok (see article titled "Cyclic Universe" in POPULAR MECHANICS, August 2007 issue). They might exist in the same space we do but in a different branch of the quantum wave function, as advocated by David Deutsch. They might not have a location, being completely disconnected from our spacetime, as suggested by Tegmark and Dennis Sciama.

Of these options, the most widely

on their most comprehensive theory of Nature: string theory.

String theory allows bubbles to look very different from one another. In effect, each begins life not only with a random distribution of matter but also with random types of matter. Our Universe contains particles such as electrons and quarks interacting through forces such as electromagnetism; other universes may have very different types of particles and forces – which is to say, different local laws of physics. The full set of allowed local laws is known as the landscape. In some interpretations of string theory, the landscape is immense, ensuring a tremendous diversity of universes.

theories without worrying about how it comes to be – which is what concerns cosmologists.

For a cosmologist, the basic problem with all multiverse proposals is the presence of a cosmic visual horizon. The horizon is the limit to how far away we can see, because signals travelling toward us at the speed of light (which is finite) have not had time since the beginning of the Universe to reach us from farther out. All the parallel universes lie outside our horizon and remain beyond our capacity to see, now or ever, no matter how technology evolves. In fact, they are too far away to have had any influence on our Universe whatsoever. That is why none of

'If we had proof that string theory is correct, its theoretical predictions could be a legitimate, experimentally based argument for a multiverse. We do not have such proof.'

accepted is that of chaotic inflation, and I will concentrate on it; however, most of my remarks apply to all the other proposals as well. The idea is that space at large is an eternally expanding void, within which quantum effects continually spawn new universes like a child blowing bubbles. The concept of inflation goes back to the 1980s, and physicists have elaborated on it based

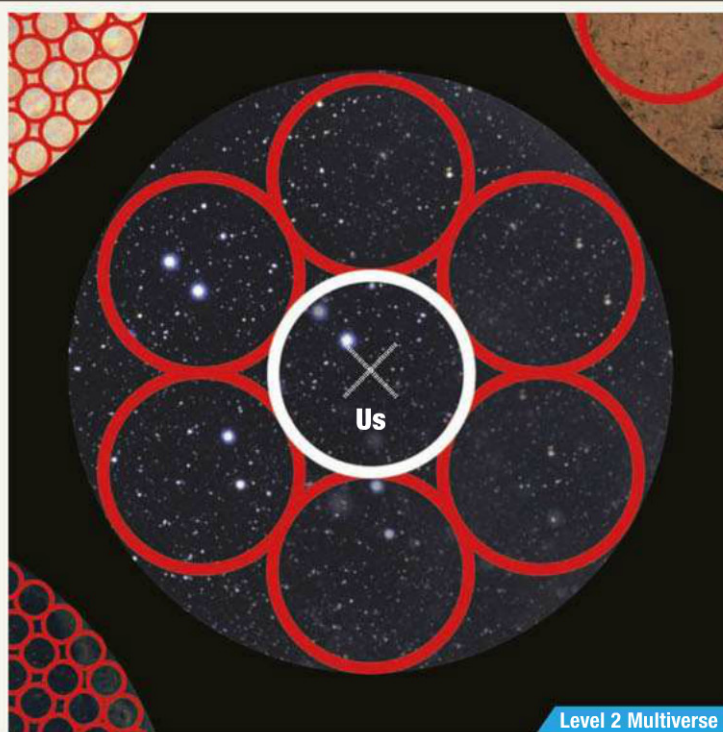
Many physicists who talk about the multiverse, especially advocates of the string landscape, do not care much about parallel universes per se. For them, objections to the multiverse as a concept are unimportant. Their theories live or die based on internal consistency and, one hopes, eventual laboratory testing. They assume a multiverse context for their

the claims made by multiverse enthusiasts can be directly substantiated.

The proponents are telling us we can state in broad terms what happens 1 000 times as far as our cosmic horizon, 10 100 times, 101 000 000 times, an infinity – all from data we obtain within the horizon. It is an extrapolation of an extraordinary kind.



Level 1 Multiverse



Level 2 Multiverse

Maybe the Universe closes up on a very large scale, and there is no infinity out there.

Maybe all the matter in the Universe ends somewhere, and there is empty space forever after. Maybe space and time come to an end at a singularity that bounds the Universe. We just do not know what actually happens, for we have no information about these regions and never will.

SEVEN QUESTIONABLE ARGUMENTS

Most multiverse proponents are careful scientists who are quite aware of this problem but think we can still make educated guesses about what is going on out there. Their arguments fall into seven broad types, each of which runs into trouble.

Space has no end. Few dispute that space extends beyond our cosmic horizon and that many other domains lie beyond what we see. If this limited type of multiverse exists, we can extrapolate what we see to domains beyond the horizon, with more and more uncertainty as regards the farther-out regions. It is then easy to imagine more elaborate types of variation, including alternative physics occurring out where we cannot see.

But the trouble with this type of extrapolation, from the known to the unknown, is that no one can prove you wrong. How can scientists decide whether their picture of an unobservable region of spacetime

is a reasonable or an unreasonable extrapolation of what we see? Might other universes have different initial distributions of matter, or might they also have different values of fundamental physical constants, such as those that set the strength of nuclear forces? You could get either, depending on what you assume.

Known physics predicts other domains. Proposed unified theories predict entities such as scalar fields, a hypothesised relative of other space-filling fields such as the magnetic field. Such fields should drive cosmic inflation and create universes ad infinitum. These theories are well grounded theoretically, but the nature of the hypothesised fields is unknown, and experimentalists have yet to demonstrate their existence, let alone measure their supposed properties. Crucially, physicists have not substantiated that the dynamics of these fields would cause different laws of physics to operate in different bubble universes.

The theory that predicts an infinity of universes passes a key observational test.

The cosmic microwave background radiation reveals what the Universe looked like at the end of its hot early expansion era. Patterns in it suggest that our Universe really did undergo a period of inflation. But not all types of inflation go on forever and create an infinite number of bubble universes. Observations do not single

out the required type of inflation from other types. Some cosmologists, such as Steinhardt, even argue that eternal inflation would have led to patterns in the background radiation that are different to those we see.

Linde and others disagree. Who is right? It all depends on what you assume about the physics of the inflationary field.

Fundamental constants are finely tuned for life. A remarkable fact about our Universe is that physical constants have just the right values needed to allow for complex structures, including living things. Steven Weinberg, Martin Rees, Leonard Susskind and others contend that an exotic multiverse provides a tidy explanation for this apparent coincidence: if all possible values occur in a large enough collection of universes, then viable ones for life will surely be found somewhere.

This reasoning has been applied, in particular, to explaining the density of the dark energy that is speeding up the expansion of the Universe today. I agree that the multiverse is a possible valid explanation for the value of this density; arguably, it is the only scientifically based option we have right now. But we have no hope of testing it observationally. Additionally, most analyses of the issue assume the basic equations of physics are the same everywhere, with only the constants differing – but if one takes the

multiverse seriously, this need not be so.

Fundamental constants match multiverse predictions. This argument refines the previous one by suggesting that the Universe is no more finely tuned for life than it strictly needs to be. Proponents have assessed the probabilities of various values of the dark energy density. The higher the value is, the more probable it is, but the more hostile the Universe would be to life.

The value we observe should be just on the borderline of uninhabitability, and it does appear to be so (see illustration). Where the argument stumbles is that we cannot apply a probability argument if there is no multiverse to apply the concept of probability to. This argument thus assumes the desired outcome before it starts; it simply is not applicable if there is only one physically existing universe. Probability is a probe of the consistency of the multiverse proposal, not a proof of its existence.

String theory predicts a diversity of universes. String theory has moved from being a theory that explains everything to a theory where almost anything is possible. In its current form, it predicts that many essential properties of our Universe are pure happenstance. If the Universe is one of a kind, those properties seem inexplicable. How can we understand, for example, the fact that physics has precisely those highly constrained properties that allow life to exist? If the Universe is one of many, those properties make perfect sense. Nothing singled them out; they are simply the ones that arose in our region of space.

Had we lived elsewhere, we would have observed different properties, if we could

able laws apply somewhere. The idea is inspired in part by quantum mechanics, which, as Murray Gell-Mann memorably put it, holds that everything not forbidden is compulsory. A particle takes all the paths it can, and what we see is the weighted average of all those possibilities.

Perhaps the same is true of the entire Universe, implying a multiverse. But astronomers have not the slightest chance of observing this multiplicity of possibilities. Indeed, we cannot even know what the possibilities are. We can only make sense of this proposal in the face of some unverifiable organising principle or framework that decides what is allowed and what is not – for example, that all possible mathematical structures must be realised in some physical domain (as proposed by Tegmark).

But we have no idea what kinds of existence this principle entails, apart from the fact that it must, of necessity, include the world we see around us. And we have no way whatsoever to verify the existence or nature of any such organising principle. It is in some ways an attractive proposition, but its proposed application to reality is pure speculation.

ABSENCE OF EVIDENCE

Although the theoretical arguments fall short, cosmologists have also suggested various empirical tests for parallel universes. The cosmic microwave background radiation might bear some traces of other bubble universes if, for example, our Universe has ever collided with another bubble of the kind implied by the chaotic inflation scenario. The background radiation might also contain remnants of universes that existed before the Big Bang in an endless cycle of universes.

so immutable after all. Some astronomers claim to have found such variations. Most, though, consider the evidence dubious. A third test is to measure the shape of the observable Universe: is it spherical (positively curved), hyperbolic (negatively curved) or 'flat' (uncurved)?

Multiverse scenarios generally predict that the Universe is not spherical, because a sphere closes up on itself, allowing for only a finite volume. Unfortunately, this test is not a clean one. The Universe beyond our horizon could have a different shape from that in the observed part; what is more, not all multiverse theories rule out a spherical geometry.

A better test is the topology of the Universe: does it wrap around like a doughnut or pretzel? If so, it would be finite in size, which would definitely disprove most versions of inflation and, in particular, multiverse scenarios based on chaotic inflation.

Such a shape would produce recurring patterns in the sky, such as giant circles in the cosmic microwave background radiation. Observers have looked for and failed to find any such patterns. But this null result cannot be taken as a point in favour of the multiverse.

Finally, physicists might hope to prove or disprove some of the theories that predict a multiverse. They might find observational evidence against chaotic versions of inflation or discover a mathematical or empirical inconsistency that forces them to abandon the landscape of string theory. That scenario would undermine much of the motivation for supporting the multiverse idea, although it would not rule the concept out altogether.

'If the multiverse exists, did it come into existence through necessity, chance or purpose?'

indeed exist there (life would be impossible in most places). But string theory is not a tried-and-tested theory; it is not even a complete theory. If we had proof that string theory is correct, its theoretical predictions could be a legitimate, experimentally based argument for a multiverse. We do not have such proof.

All that can happen, happens. In seeking to explain why Nature obeys certain laws and not others, some physicists and philosophers have speculated that Nature never made any such choice: all conceivable

These are indeed ways one might get real evidence of other universes. Some cosmologists have even claimed to see such remnants. The observational claims are strongly disputed, however, and many of the hypothetically possible multiverses would not lead to such evidence. So observers can test only some specific classes of multiverse models in this way.

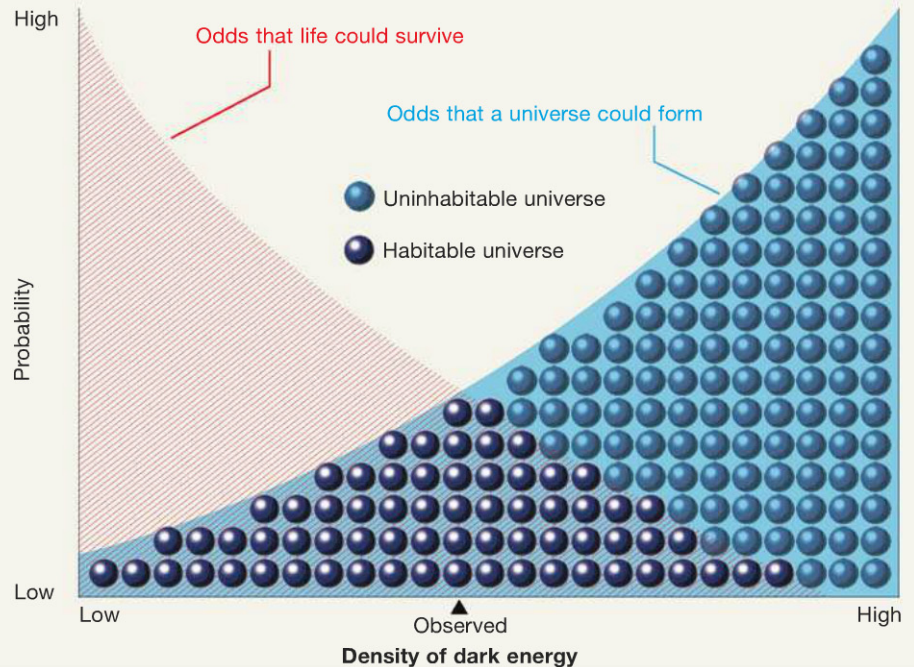
A second observational test is to look for variations in one or more fundamental constants, which would corroborate the premise that the laws of physics are not

TOO MUCH WIGGLE ROOM

All in all, the case for the multiverse is inconclusive. The basic reason is the extreme flexibility of the proposal: it is more a concept than a well-defined theory. Most proposals involve a patchwork of different ideas rather than a coherent whole. The basic mechanism for eternal inflation does not itself cause physics to be different in each domain in a multiverse; for that, it needs to be coupled to another speculative theory. Although they can be fitted together, there is nothing inevitable about it.

DOES THE GLOVE FIT?

As evidence for a multiverse, proponents often cite the density of the dark energy that dominates our Universe. The process of eternal inflation endows each universe in a multiverse with a random density of dark energy. Relatively few universes have zero or a low value; most have higher values (blue area). But too much dark energy tears apart the complex structures needed to sustain life (red area). So most habitable universes should have a middling density of dark energy (peak of overlap region) – and, lo and behold, our Universe does. Multiverse sceptics, though, say this reasoning is circular: it holds only if you assume the multiverse to begin with. It is a consistency test, not a proof.



The key step in justifying a multiverse is extrapolation from the known to the unknown, from the testable to the untestable. You get different answers depending on what you choose to extrapolate. Because theories involving a multiverse can explain almost anything whatsoever, any observation can be accommodated by some multiverse variant. The various “proofs,” in effect, propose that we should accept a theoretical explanation instead of insisting on observational testing. But such testing has, up until now, been the central requirement of the scientific endeavour, and we abandon it at our peril. If we weaken the requirement of solid data, we weaken the core reason for the success of science over the past centuries.

Now, it is true that a satisfactory unifying explanation of some range of phenomena carries greater weight than a hodgepodge of separate arguments for the same phenomena. If the unifying explanation assumes the existence of unobservable entities such as parallel universes, we might well feel compelled to accept those entities. But a key issue here is how many unverifiable entities are needed. Specifically, are we hypothesising more or fewer entities than the number of phenomena to be explained?

In the case of the multiverse, we are supposing the existence of a huge number – perhaps even an infinity – of unobservable entities to explain just one existing universe. It hardly fits 14th-century English philosopher William of Ockham’s stricture that “entities must

not be multiplied beyond necessity”.

Proponents of the multiverse make one final argument: that there are no good alternatives. As distasteful as scientists might find the proliferation of parallel worlds, if it is the best explanation, we would be driven to accept it; conversely, if we are to give up the multiverse, we need a viable alternative. This exploration of alternatives depends on what kind of explanation we are prepared to accept.

Physicists’ hope has always been that the laws of Nature are inevitable – that things are the way they are because there is no other way they might have been – but we have been unable to show this is true.

Other options exist, too. The Universe might be pure happenstance – it just turned out that way. Or things might in some sense be meant to be the way they are – purpose or intent somehow underlies existence. Science cannot determine which is the case, because these are metaphysical issues.

Scientists proposed the multiverse as a way of resolving deep issues about the nature of existence, but the proposal leaves the ultimate issues unresolved. All the same issues that arise in relation to the Universe arise again in relation to the multiverse. If the multiverse exists, did it come into existence through necessity, chance or purpose? That is a metaphysical question that no physical theory can answer for either the Universe or the multiverse.

To make progress, we need to keep to the idea that empirical testing is the core of science. We need some kind of causal contact with whatever entities we propose; otherwise, there are no limits.

The link can be a bit indirect. If an entity is unobservable but absolutely essential for properties of other entities that are indeed verified, it can be taken as verified. But then the onus of proving it is absolutely essential to the web of explanation. The challenge I pose to multiverse proponents is: can you prove that unseeable parallel universes are vital to explain the world we do see? And is the link essential and inescapable?

As sceptical as I am, I think the contemplation of the multiverse is an excellent opportunity to reflect on the nature of science and on the ultimate nature of existence: why we are here. It leads to new and interesting insights and so is a productive research programme. In looking at this concept, we need an open mind, though not too open. It is a delicate path to tread.

Parallel universes may or may not exist; the case is unproved. We are going to have to live with that uncertainty. Nothing is wrong with scientifically based philosophical speculation, which is what multiverse proposals are. But we should name it for what it is.

PM

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SUPER

Weather forecaster

Nuclear simulator

by Glenn Derene

Gene sequencer

Oil prospector

Market analyser

3D visualiser

Behaviour tracker

Number cruncher

COMPUTER

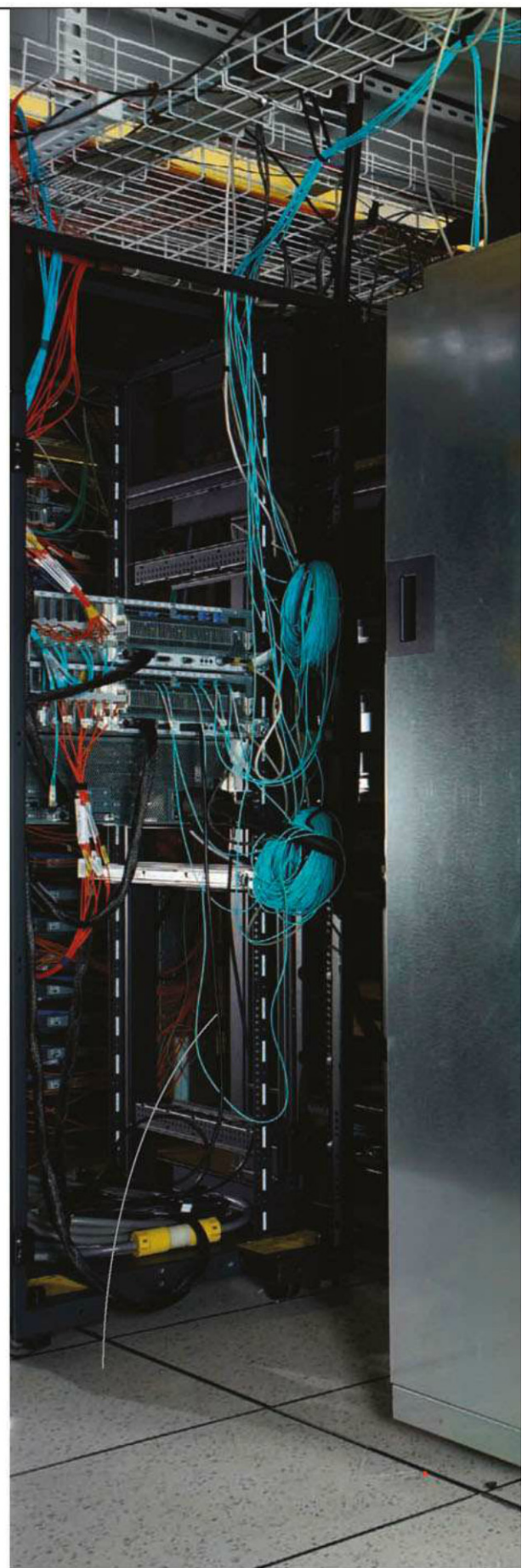
Pictures by Ian Allen

Data miner

Chris Marroquin is waist-deep in a hole in the floor. He's a tall guy with a medium build, but he looks awfully short now, and his shirt is pumped up to Schwarzenegger size by a 15-degree breeze blustering all around him. Grappling with a 25 mm-diameter hose, he attempts to explain the liquid-cooling system of IBM's next-generation supercomputer to me, but I can barely hear him over the howling wind.

We're in a development room of IBM's facility at Rochester, Minnesota, where engineers test and assemble the company's Blue Gene supercomputers. The air buffeting Marroquin cools a small, four-rack Blue Gene/P system capable of 13,9 teraflops per rack, but the hose he's holding is part of a far more advanced cooling system.

Filled with de-ionised water, the anti-corrosive agent benzotriazole and a dose of biocide, the tube feeds into a prototype of the company's new Blue Gene/Q computer. The Blue Gene/Q rack sitting on the raised floor has its own circulatory system – 250 metres of copper pipe, with check valves, quick-disconnect rubber hoses and an electronic monitor that measures





Fibre optic networking and power cables intermingle with flexible rubber hoses carrying cooling water to a prototype IBM Blue Gene/Q supercomputer.

Anatomy of a supercomputer

flow rate, pressure and dew point – designed to shut down if anything goes awry. “You don’t want any drips,” Marroquin says.

As sophisticated as the cooling system is, what launches this machine into the realm of technological superlatives is its processing power: each rack contains 1 024 computer chips, and every one of those chips has 16 processor cores. That’s a total of 16 384 processors, making it capable of 209 teraflops, 15 times more power per rack than the Blue Gene/P. Within the next year IBM will ship 96 Blue Gene/Q racks to Bruce Goodwin at Lawrence Livermore National Laboratory (LLNL) in California. Collectively, those racks will become the most powerful computer in the world. It should be able to predict the path of hurricanes, decode gene sequences and analyse the ocean floor to discover oil. But Goodwin primarily wants to use it to blow up a nuclear bomb.

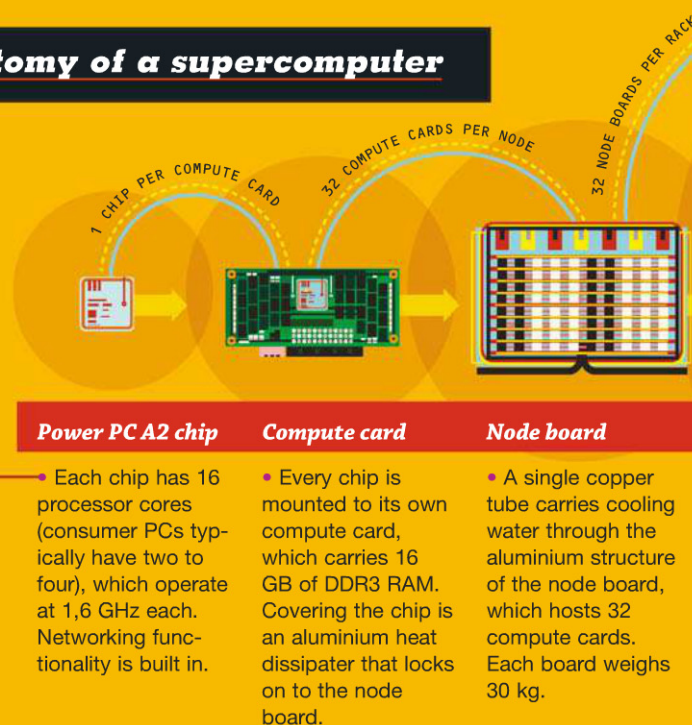
Goodwin used to explode nukes the old-fashioned way. From 1983 to 1991, he designed and oversaw five nuclear weapons tests at the US Department of Energy’s Nevada Test Site. He and other engineers would dig a 600-metre-deep hole, toss a warhead and some highly specialised monitoring equipment into a 10-storey, 500-ton iron canister and lower it into the hole. Then everybody would move way the heck back, cross their fingers and detonate. Sitting in the control room 15 kilometres away, “it felt like a magnitude 5 or 6 earthquake”, Goodwin says.

All that changed in October 1992, when then US President George H W Bush declared a moratorium on nuclear testing in anticipation of the Comprehensive Nuclear-Test-Ban Treaty of 1996. After that, if the United States wanted to test any of the warheads in its multi-thousand-weapon arsenal, it had to do a computer simulation.

Really powerful computers have been around as long as computers themselves, but the term supercomputer didn’t arrive until 1976, when Seymour Cray built the Cray-1. It cost R70 million (R275 million in today’s money) and cranked up to 160 megaflops. Yesterday’s supercomputer, however, has less power than today’s personal computer – a modern PC has more than 50 times the processing power of the original Cray. In fact, the “super” prefix is so fuzzy that many computer scientists eschew the term supercomputer altogether and call such machines high-performance computers, or HPCs.

In an attempt to bring some clarity to the genre, in 1993 a private group called the Top500 project started publishing a twice-yearly list of the 500 most powerful computers in the world. If your computer is on the list, it is by definition a supercomputer.

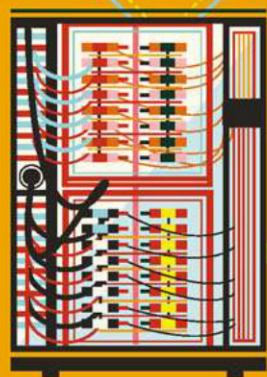
For 17 of the Top500 list’s 18 years, the US and Japan have swapped supremacy. But, in October 2010, China claimed the top spot with the 2,6-petaflop Tianhe-1A. The computer



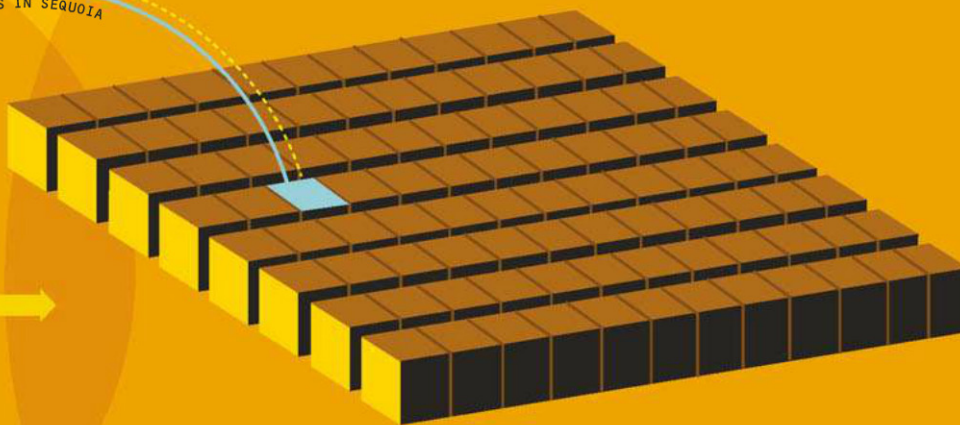
scientists who design and build these systems tend to work for multinational companies and are cautious about characterising what they do as a statement of national pride. Regardless, supercomputers have come to symbolise the technological prowess of the countries that build them – a silicon-age version of the space race. In a sign of the whipsaw speed of technological progress, Japan eclipsed China just eight months later, in June 2011, unveiling the 8-petaflop K Computer. The Chinese countered in August, outlining a road map to “exascale” computing, essentially promising a 125-fold increase in computing power within 10 years. If Tianhe-1A was China’s Sputnik moment, exascale is its Moonshot.

The supercomputer’s role in maintaining America’s nuclear weapons justifies its status as a national security interest. But China’s challenge to the West’s computing dominance has led many computer scientists and policy wonks to claim that supercomputing is essential to US economic security as well. These machines are force multipliers for American scientists, engineers and businesses, the argument goes, and whoever builds the best ones gains an advantage. Supercomputers don’t just reflect intellectual and technological power, they also reinforce it.

The folks at IBM Rochester betray little interest in China’s goal of supercomputing dominance. Their job is to work out the engineering for Blue Gene/Q, and they deliberately focus on the technology, not the politics. They are classic pocket-protector engineers, and their titles are inelegant bureaucratic artefacts that offer little clue to their actual roles. “We’re a very small, roll-up-your-sleeves team effort,” says Pat Mulligan, development manager for Global Server Integration (who, for the record, had his sleeves rolled up when we spoke). “We’re not overly nationalistic, we just



96 RACKS IN SEQUOIA



Rack

- Thirty-two node boards slide into a rack, like drawers in a dresser. A single rack holds 1 204 chips. Multiple high-speed networking technologies are built in so that data can pass from chip to chip without having to leave the rack.

Supercomputer

- Racks can operate independently, but performance scales up as they are used in parallel. Sequoia, scheduled to go online in 2012, will have 96 racks and will be capable of 20 quadrillion calculations a second.



The electricity use of
7 200 homes

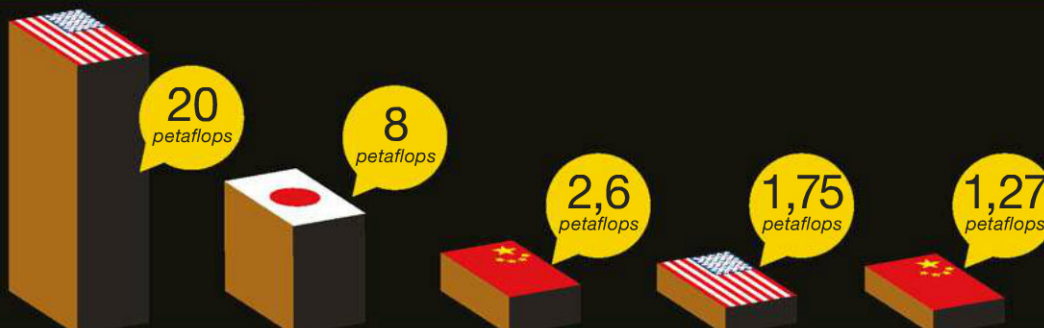


The computing power of
2 million laptops

SEQUOIA IS
EQUIVALENT TO

Top 5 Supercomputer sites

When Sequoia is fully operational in 2012, it is expected to become the most powerful computer on Earth. How does it compare?



Location	LIVERMORE, CALIFORNIA	KOBE, JAPAN	TIANJIN, CHINA	OAK RIDGE, TENNESSEE	SHENZHEN, CHINA
Computer	Sequoia	K Computer	Tianhe-1A	Jaguar	Nebulae
Laboratory	Lawrence Livermore National Laboratory	Riken Advanced Institute for Computational Science	National Supercomputing Centre	Oak Ridge National Laboratory	National Supercomputing Centre

want to make the best computer we can.”


The building where Marroquin, Mulligan and the rest of the IBM team are creating the 21st century’s most powerful computers is a monument to mid-20th-century corporate futurism. Designed by architect Eero Saarinen, the sprawling structure is clad in dark blue glass. Hallways a kilometre long stretch through the interior. At some point IBM – always pushing the technological envelope – concealed wires in the hallway floors to guide robots that delivered parts and machinery from one assembly room to another. The robots are long gone, a dream of mechanical efficiency undone by reality: they were slow and broke down so often that the facility switched to human-guided forklifts.

The Blue Gene/Q computers I’m getting a look at are not part of Bruce Goodwin’s supercomputer (named

Sequoia). These are test models, used to work out the kinks in the hardware and software. The manufacturing of Sequoia’s 96 racks was due

to ramp up soon after my visit, but Goodwin and his team at Lawrence Livermore are already logging in to Blue Gene/Q and tinkering from afar; a sign on one of the racks in the Rochester assembly room says LLNL remote access machine.

Goodwin’s Terascale Simulation Facility (TSF) at Livermore is one of two Energy Department centres that perform nuclear simulations as part of the Stockpile Stewardship Programme (the other is at Los Alamos National Laboratory in New Mexico). To get a simulation that delivers an acceptable degree of accuracy, Goodwin’s team models a 50-microsecond explosion in three dimensions down to a scale of 10 microns. “It gets very complicat-



Behold the guts of what will soon be the world's most powerful computer, the Blue Gene/Q.

ed," Goodwin says. "These things are imploding and exploding, and you have to track the fluid mechanics with the precision of a Swiss watch." Every time a component is changed or upgraded in a US nuclear warhead, the TSF virtually tests the bomb to make sure it will still go boom. The computer simulations have revealed aspects of nuclear fission that testers hadn't anticipated, and, consequently, the number and complexity of algorithms have increased over time.

Modern simulations model only parts of a full explosion, and even then, the most complex sims Goodwin runs use about a million lines of code. If you had 1 600 years, the calculations could conceivably be done on a laptop; Livermore's current 500-teraflop Blue Gene/P system, named Dawn, gets a high-complexity sim done in a month. When the 20-petaflop Sequoia system goes live in 2012, the test time should drop to a week.

To understand supercomputers, you need to understand flops, or floating-point operations per second. Flops are essentially maths with decimals, as opposed to integer calculations, which require whole numbers. When it comes to hardcore number-crunching, flops are more data-efficient than integers – consider Avogadro's number, expressed as $6,02 \times 10^{23}$, compared with its integer alternative, which would fill out most of this sentence. High-performance computers are super-floppers: Sequoia's 20 petaflops equals 20 quadrillion calculations per second.

So high-performance computing is predicated on the idea that many of the world's most complicated problems are ultimately reducible to pure maths. And those problems range from matters of national security (the viability of Goodwin's nukes) to day-to-day concerns (predicting the weather this weekend – and the weekend after that). Not only are supercomputers routinely used in research (climate modelling, gene sequencing, artificial intelligence), but they are also becoming essential to commercial enterprises such as drug development, oil exploration and aircraft and automotive design, as well as product R&D.

For example, Arizona-based Ping has used Cray supercomputers to aid in golf-club design. Supercomputers let companies speed products through the development cycle by virtualising much of the design and testing. High-performance comput-

The logic for building supercomputers is strikingly similar to that of nuclear deterrence. We must have more computing power than our competitors or they will use their technological superiority against us.

ing can also have more ominous consequences – Wall Street's "flash crash" in May 2010 was caused by a chain reaction of HPCs making high-frequency trades that drove the Dow down 600 points in 5 minutes.

The secret to supercomputing is parallel processing. The design of a supercomputer allows the machine to break up a task – say, predicting the path of a tornado – into lots of interdependent calculations, then groups of processors crunch the numbers all at once. To make things even faster, each of Sequoia's chips has onboard networking and can share data directly with any other chip in its rack.

It's a brute-force approach to maths, and it is surprisingly powerful. A Blue Gene/P computer recently calculated pi to the billionth digit. It's also surprisingly scalable. Sequoia will have 96 racks, but Dr George Chiu, one of IBM's top HPC scientists, claims that, with a few simple hardware and software changes, Blue Gene/Q could theoretically support up to 32 768 racks, with an estimated compute power of 6 848 petaflops. "The actual limit is the (money) you're willing to spend," Chiu says. "And, of course, you have to have the power."

Oh, yes, electricity. That's the other big issue with HPCs. Sequoia will be the most powerful supercomputer in the world, but it will also be one of the most power-hungry. At peak load, Sequoia is expected to operate at 9-plus megawatts, enough to power more than 7 200 homes. It turns out, however, that Sequoia will also be the world's most power-efficient computer, churning out 2 gigaflops per watt. By comparison, the K Computer in Japan, which operates at

9,9 megawatts, puts out just 800 megaflops per watt – accomplishing only 40 per cent of the calculations with the same electricity. But like processing power, electricity use scales linearly as you add racks to a supercomputer. If you double the racks on Sequoia, you get a computer that's twice as fast – but you also get a computer that's twice as power-hungry. Being the world's most efficient computer helps to mitigate that consumption, but only to a point.

China isn't the only country aiming for exascale. The US Department of Energy deems it critically important to American technological competitiveness, and companies such as Intel and Nvidia are promising exascale performance by the end of this decade. It's a technological challenge that goes beyond mere improvements in processing power. "To build exascale you have to have a vision of what applications will look like 10, 15 and 20 years from now," says Dave Turek, IBM's vice-president of exascale computing. Turek and his contemporaries foresee a future where the volume and speed of data coming at machines like this will be several orders of magnitude higher than it is now, and will require a ground-up re-engineering of some of the fundamentals of computing, such as data storage, networking, software and power systems.

Supercomputing is an expensive hobby for a nation to have. The Energy Department puts the combined development costs of Sequoia and Blue Gene/P Dawn at about R2 billion. Plus, the annual electric bill to operate a petascale computer

runs R40 million to R80 million. High-performance-computer scientists know that costs like these can't be allowed to scale along with the gains expected from exaflop machines.

But Goodwin and others in his field see these computers as essential. He points out that China's government has a stated goal of using supercomputers to gain an industrial edge, and we should be doing the same. "We can do all of the engineering 'what ifs' on a supercomputer and bring a product to market five times faster than when you actually had to make things to see if they worked," he says. "Think about what it means to the economy if Boeing, General Motors or General Electric can get to market in months instead of years. It matters, and if someone can get there five times faster than you, you're going to go out of business."


The US justifies the expense of these machines today because it helps to maintain the country's nuclear stockpile, but the logic for building them in the future is strikingly similar to that of nuclear deterrence itself. We must have more computing power than our competitors or they will use their technological superiority against us.

This made me wonder what kind of computer would be fast enough for Goodwin's 50-microsecond nuclear sims. I asked him: if a 500-teraflop computer could do it in a month, and a 20-petaflop computer could do it in a week, could an exaflop computer do it in real time? "An exaflop machine is way too slow to run such a simulation in real time," he answered via e-mail. He told me a real-time nuclear simulation would require a 100-yottaflop computer – that's 100×10^{24} calculations a second, 100 million times faster than an exaflop machine. Another floating-point operation.

PM

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THEY DON'T COME SMARTER

Designing a smartphone that can be all things to all people is nigh on impossible. However, the boffins at Motorola seem to have managed just that. To say the all-new Razr is an impressive handset would be an understatement. Its decidedly classy slimline look (it's only 7,1 mm thick) is backed up by cutting-edge tech featuring a hefty 11 cm Super AMOLED touchscreen display that's protected by Corning Gorilla glass and a textured back made out of Kevlar. Apart from the tough cladding, it features a diamond-cut aluminium frame and every component (inside and out, including the electrical boards) is protected by a splash-guard coating – making it more than capable of handling the rigours of everyday life.

On the inside, you get 1 GB of RAM, a dual-core 1,2 GHz processor and an Android 2.3 (Gingerbread) operating system. It's a combo that promises a lightning-fast user interface with some serious multitasking muscle. There's a front-facing 720p HD video camera, an 8MP rear-facing camera with even sharper 1080p HD video capture, 11,5 GB of usable storage (expandable up to 32 GB) and government-grade encryption.

The new Razr also comes preloaded with a number of handy apps. Here's but one example: MotoCast facilitates the direct streaming or downloading of content from your home or work PC to your device. All your content is always readily at hand, no matter where you are. So, if you've forgotten your presentation at the office, it's no longer a train smash: all you need do is download the necessary data and then connect your handset to any available PC or monitor. Optional extras include a multimedia station to facilitate large-screen entertainment, and two docking stations (the Lapdock 500 Pro with its 35 cm HD screen, and the smaller Lapdock 100 featuring a 25 cm screen) that effectively turn the handset into a laptop. Price: about R7 000.

Visit www.motorola.com/mobility





COMPACT CONTENT PROVIDER

If you want to immerse yourself in digital content from the comfort of your lounge or TV room, here's a great décor tip: never clutter up the area with a hulking PC (unless wilfully incurring the wrath of your better half is your kind of thing, that is). A much better idea would be to go for Western Digital's TV Live. This diminutive, full-HD wireless streaming networked media player connects directly to your TV and pumps out your content via Wi-Fi 802.11n or Ethernet connection.

In addition to streaming Internet content at 1080p resolution, it also allows users to enjoy personal media such as photos, video and music from any connected USB drive or networked computer. When you're bored with those, it offers Fun Spot Games, a casual gaming service that has everything from arcade and card games to puzzles, strategy and quizzes, including Sudoku, Black Jack and Poker. Price: about R1 100. Contact Pinnacle Africa on 011-265 3000 or visit www.pinnacleafrica.co.za



BUSINESS MUSCLE TO GO

Having to perform at your best while on the road can be a rather exasperating exercise if you don't have the right tools. Sound familiar? Well, don't sweat. Dell's latest performer, the Vostro 3350 notebook, has got you covered. That's because it was specifically designed for harassed business travellers. Performance is enhanced with DDR3 memory, Intel's Core i5 processor and an upgrade to Windows 7 Professional. It features 4 GB of RAM, a 500 GB hard drive and an embedded 3G modem.

Because time is money, it includes two USB 3.0 ports that enable data transfers of up to 10 times the speed of USB 2.0. Bluetooth 3.0 lets you transfer at up to 24 Mbps, giving you the ability to move large files in just a few seconds. Handy features such as a built-in HD Web cam, digital array microphones (to omit background noise), preinstalled Skype and SRS Premium Voice Pro software allow you to stay in touch with family and colleagues when out of town. It boasts a battery life of up to 12 hours, and a backlit keyboard is an optional extra. Price: about R10 000. Contact distributor Drive Control Corporation on 011-201 8927 or visit www.drivecon.net

OH, THE CONTROL

Looking for a way to control systems around your home, farm or business while you're away enjoying life? Then look no further. The GSM Commander, a programmable controller that has cellular communication abilities built right in, is your answer. It's ideal for any situation where equipment or assets need to be controlled remotely: think refrigeration, security, agriculture, logistics, metering and who-knows-what else. Depending on the model, messages can be sent to a phone, or data can be logged to a secure database. The included software allows devices to be configured directly via USB or remotely via the Internet. And, as its programming language is English, you don't have to be a rocket scientist to configure it.

There are three models in the range, and all come with a basic two input/two output configuration. The GC0321 can be expanded to include 24 inputs and outputs and is programmable via USB or PC. The GC0641 handles up to 44 inputs and outputs, and is GPRS enabled. And the big daddy of the range, the GC1281, can be configured to include as many as 64 inputs and outputs. It is also GPRS enabled and can accommodate dual SIM cards. Expect to pay between R1 300 and R4 000 (depending on what model and configuration options you go for). Contact Polygon Technologies on 021-981 7062 or visit www.gsmcommander.com





TOUCH YOUR TELLY

Touch displays have become the norm in phones and tablets, but remain unheard of in TVs – until now, that is. LG's new Plasma Pentouch TV boasts all the advantages of a PC with Internet access, while letting users control content directly on the screen using a special pen.

Users can activate the Pentouch mode with a single click on the remote. The interface itself is described as being intuitive and easy to navigate. In Pentouch mode, users can access files, such as PowerPoint and other content, from their PCs. These files can then be worked on or edited on the screen from the comfort of a lounge chair. This high-tech telly supports simultaneous two-pen use, and the pen batteries can be recharged via USB ports on the back of the unit to ensure a functional pen is available whenever it's required.

Using the included software suite, budding artists can draw pictures directly on to the screen and then save files for further editing or effects manipulation. And, if your PC is connected to a printer, you can print out your creations, too. Other features include Gallery (which includes a built-in slide show feature), Family Calendar, Digital Photo Frame (this lets you embellish images with the frame of your choice) and Internet connectivity.

There's a protective scratch-free glass screen, and the unit comes with a four-legged stand that's been specifically designed to ensure stability when children are using the Pentouch feature. Expect to pay about R26 000 for the 60PZ850 (with 3D capability) and around R11 000 for the 50PT490 (without 3D capability). Contact LG on 0800 545 454 or visit www.lg.com/za

PRINTING WITHOUT PAIN

Printing across a network – or across the world, for that matter – just got a whole lot easier. Kodak's ESP 2170 All-In-One inkjet printer is a compact print, copy scan and fax device that boasts Wi-Fi 802.11 b/g/n connectivity to make accessing your home's wireless network a cinch. Apart from that, it also allows you to print from anywhere via your smartphone, tablet or laptop when using Google Cloud Print or Kodak Email Print (two free services that can be accessed via the Internet).

Kodak's Pic Flick application facilitates the printing of multiple-sized photos directly from your iPhone, iPod Touch, Blackberry or Android device. Its pigment-based inks produce long-lasting, sharp documents and lab-quality photos that don't cost a fortune. An intelligent paper sensor automatically adjusts printer settings based on the paper type, so you get the right print first time.

On the work front, Kodak's Perfect Page scanning feature improves and corrects less-than-perfect originals to make documents easier to read. Throughput is good, with a robust 150-sheet rear feed paper tray and 25-page automatic document feeder. It will copy 5 black and 3 colour pages per minute, the 1 200 DPI scanner can scan multiple photos simultaneously and separate files automatically and its fax modem has a speed of 33,6 kb per second. Scans can be sent to your PC, e-mail, network folders, memory cards or USB flash drives. Price: about R1 500. Contact Incredible Connection 0860 011 700 or visit www.incredible.co.za





TAKE NOTE

Not sure if you want a tablet PC or high-end smartphone? Well, Samsung's latest device helps make your choice a little easier: the Galaxy Note combines both tablet and smartphone into a single device. It has all the functionality you'd expect from a sophisticated handset – think 1,4 GHz dual core processor, Android 2.3 (Gingerbread) operating system, Wi-Fi 802.11 a/b/g/n and Bluetooth 3.0 + HS connectivity as well as 16 GB of internal storage (expandable via microSD card). What really makes the Note stand out from the crowd is its 13,5 cm WXGA HD Super AMOLED touchscreen. Used with an S Pen stylus, it provides advanced pen-input technology never seen before.

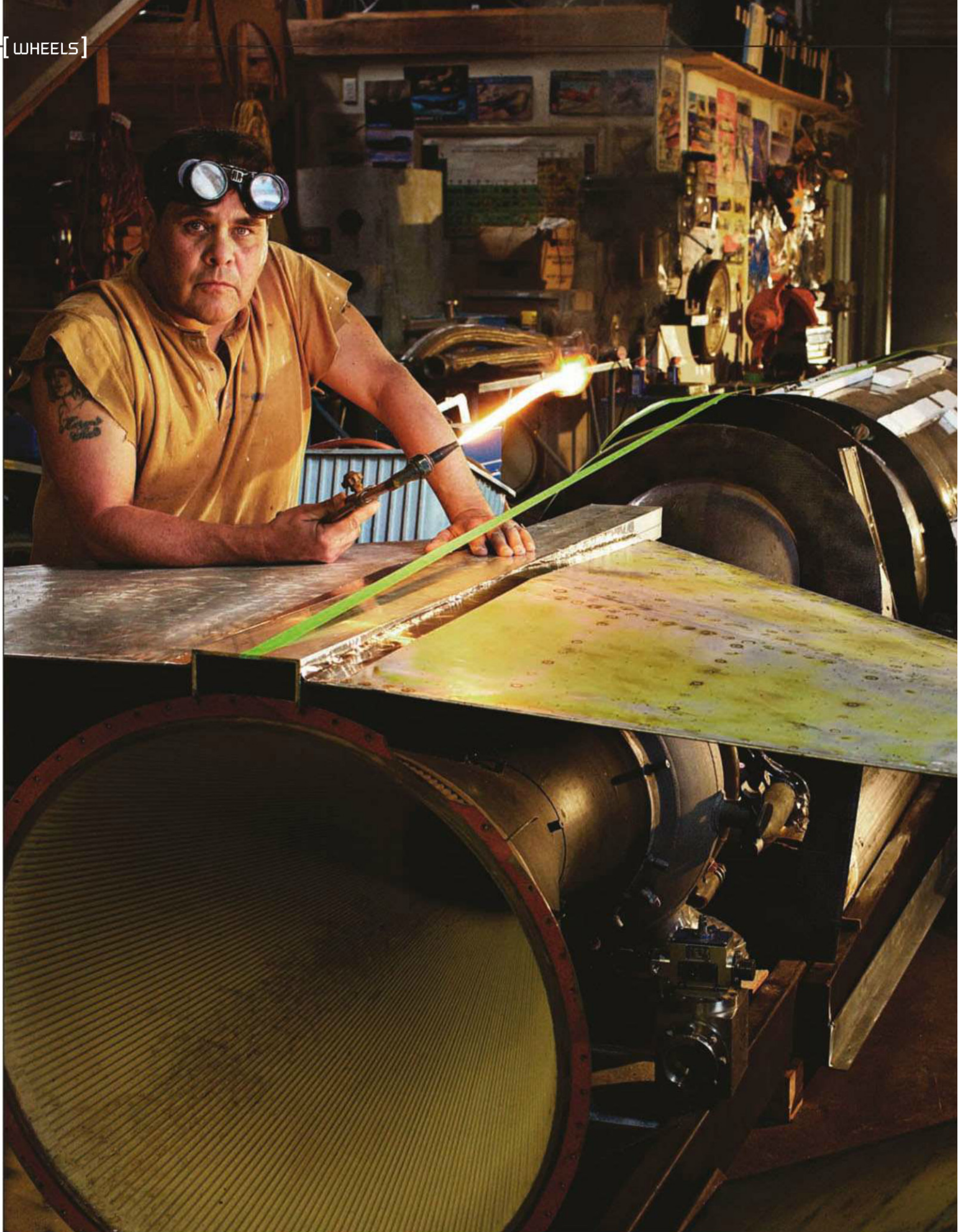
It fits into a jacket pocket (it measures about 147 x 83 x 10 mm), and thanks to its impressive screen size, PowerPoint presentations, Web pages and e-books can be viewed comfortably with minimal scrolling or zooming. It also offers a 180-degree viewing angle, so sharing content with others is a breeze.

Apart from being a lot more precise than a fingertip, the high-tech stylus features a "shift" button. Using this button activates other functions such as grabbing screen shots (which can then be drawn on) or starts the note-taking application.

Device encryption and embedded business features make the Note great for workaholics on the move. Price: about R9 000. Contact Samsung on 0860 726 786 or visit www.samsung.com

PM







the

3000 KM/H DREAM

i

It's just another unexceptional small industrial park along the edge of the town of Apple Valley in Southern California's high desert. One cinder-block building is divided into nine 200-or-so-square-metre work spaces with roll-up garage doors. In one unit, there's a cheerleader academy. In another, a heating and ventilation company. But unit No 8 is full of aerospace hardware worthy of the Smithsonian. And it all belongs to Waldo Stakes. To Stakes, these parts aren't artefacts; they are the guts of his Sonic Wind Land Speed Research Vehicle, a rocket car he hopes will break the current land speed record of 1 227,986 km/h and believes could potentially go over 3 000 km/h.

Stakes is 56, but he could pass for a decade younger. He's a fire hydrant of a guy – tough like Joe Pesci in *Goodfellas*,

Obsessed with speed since childhood, Waldo Stakes spent decades collecting aerospace technology from the mid-20th century to use in his Sonic Wind Land Speed Research Vehicle, a rocket car he's wanted to build all his life – a rocket car he believes is capable of going 3 000 km/h.

BY JOHN PEARLEY HUFFMAN

PHOTOGRAPH BY JEFF RIEDEL



VIDEO

> Watch a video of Waldo Stakes describing the Sonic Wind LSRV in detail on www.popularmechanics.co.za

but without the menace. He's always on the verge of exploding with excitement, as if his own ideas are building up pressure inside him. Engineering terms run together in bursts of explanation and promised performance. He's a full-throttle optimist, certain that there's no challenge he can't overcome. The name Waldo, somehow, fits.

"The Sonic Wind Land Speed Research Vehicle will be the premier land speed car and the most powerful car ever seen on the planet," Stakes claims in his video tour of the project. "Nothing being built in Australia or Great Britain or planned by any nation will be able to touch this car in its velocity. And its stability will be second to none."

Stakes is a general contractor, but his career has never been the priority. In his small office, which overflows with drawings and designs, he reaches for a wooden model a little over a metre long that looks more like a dart than a car. It's the Sonic Wind. Stakes has been dreaming of it nearly his entire life and, since about 2003, spending nearly every waking moment trying to make it a reality.

Stakes's obsession with speed emerged during his knockabout Chicago-area childhood. "When I was 12 years old in 1967, I was eating some Cracker Jack, and the prize was a weirdly shaped little car," he says. It was John Cobb's Railton Mobil Special – a car that went 633 km/h in 1947. "I couldn't believe a car could go that fast. By the time I was 14, I was already building model land speed cars and reading everything on missiles and rockets and aerospace that I could."

His formal education ended when he dropped out of Elgin Community College in 1974, but Stakes's passion for speed persisted. "When you study something for 40 years – and I don't mean just think about it, but study something – you can get to be pretty good at it," he says. "I have literally a thousand books on engineering and aerodynamics. Just everything."

MOVING HIS FAMILY TO SOUTHERN

California in 1984 to be closer to the aerospace industry, Stakes was soon scouring scrapyards for parts he could use to build a rocket car. His most impressive find is a set of XLR99 rocket engines designed for NASA's legendary X-15, the stub-winged experimental plane that grabbed the flight speed record of 7 270 km/h in 1967 and has never let go.

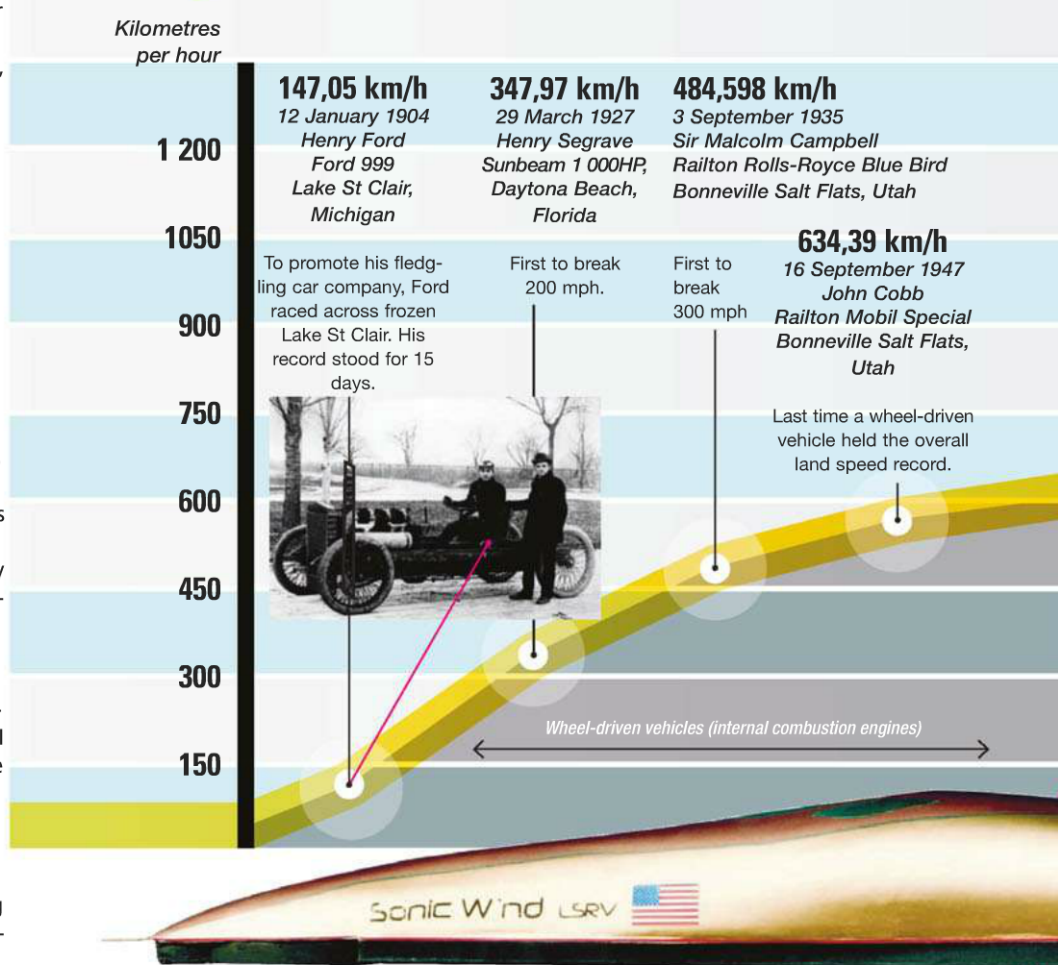
"Back in the '80s this stuff was considered

scrap metal, and everyone was melting it down to recover the silver and gold from the brazed tubing," Stakes says. "But these engines weren't built that way. They're made from Inconel-X (an exotic alloy) and virtually indestructible. I think they cost \$1 500 each for four. I have two left. One for the car and a spare."

When it was pushing X-15 pilots such as Neil Armstrong past the boundaries of Earth's atmosphere, the XLR99 delivered up to 250 000 newtons of thrust, burning liquid oxygen and anhydrous ammonia. It's a throttled rocket, capable of operating between 50 and 100 per cent thrust. Stakes is contemplating running it on a mix of methanol and liquid oxygen to produce up to 270 000 newtons of thrust.

Stakes also owns and plans to use two fuel tanks from a Redstone rocket, like the

As soon as Karl Benz took his 1886 Patent Motorwagen for its first drive, the race for faster cars was on. Here are eight of the most notable achievements in land speed history.



one that carried Alan Shepard into space in 1961, and pressure vessels from the Apollo spacecraft's service module. "This stuff is all well tested and essentially fail-proof," he says.

Through the years, Stakes has worked on other land speed projects, including a BMW-powered streamliner motorcycle that set several records in the late '80s and an 865-kW 1988 Ford Thunderbird that captured numerous records for cars with normally aspirated internal combustion engines. But Stakes is enough of a realist to recognise that the bar for admittance into what is now a supersonic club is set exponentially higher. "You can't just toss an old surplus turbojet engine into a homemade chassis anymore and go for it," he notes on a Sonic Wind website managed by his son Tone.



698,455 km/h

7 October 1964
Art Arfons
Green Monster
Bonneville Salt
Flats, Utah

During the early 1960s,
Arfons and Craig
Breedlove battled for
speed supremacy.

893,186 km/h

2 November 1965
Craig Breedlove
Spirit of America Sonic 1
Bonneville Salt Flats,
Utah

Breedlove was the first to
set records over 400 mph,
500 mph and 600 mph.

1 014,511 km/h

23 October 1970
Gary Gabelich
Blue Flame
Bonneville Salt Flats,
Utah

First record by a rocket-
powered car.

1 227,986 km/h

15 October 1997
Andy Green
ThrustSSC
Black Rock Desert,
Nevada

The current record
holder, Green was the
first to break 700 mph,
in September 1997. He
broke his own record
the next month.

Reaction engines (jet and rocket)



Roughly 1,2 m long, this is a scale
model of the Sonic Wind. If com-
pleted, the rocket car will be
14,4 m long and 2,1 m wide.

In the September 1965 issue of
POPULAR MECHANICS, Craig Breedlove
wrote about his pursuit of 750 mph
(1 200 km/h) and the possible dangers
he would face. You can find his original
story attached to this one at [www.
popularmechanics.com/2000mphcar](http://www.popularmechanics.com/2000mphcar).



As Craig Breedlove explained in POPULAR MECHANICS while he was unsuccessfully chasing a 1 200-km/h record back in 1965, shock waves, aerodynamic instability, transonic local airflows and other "fatal gremlins" can easily wreck a car at Mach 1 speeds (1 225 km/h at sea level). More than 20 engineers are working on a British bid to smash the sound barrier and hit 1 000 mph (1 600 km/h) in the Bloodhound SuperSonic car, and even after years of research and R120 million, they're not sure what will happen to their vehicle above 1 300 km/h. Stakes believes the Sonic Wind could easily reach these speeds and go well beyond, but he doesn't even have a computer in his cluttered office.

Nevertheless, he claims to know how to keep the Sonic Wind from wrecking or taking fatal flight at transonic and post-

Mach 1 speeds. "The idea is to use all the forces acting on the car to keep it stable during runs," he says. "The Sonic Wind's body changes plane slightly in the nose area. This anchors shock waves over the front wheels to increase the negative lift. These shock waves, along with the shocks that will radiate downward from the rear bi-wedge tail fins, will also be used in roll control."

At least, that's the theory. It's a theory that could use a few years of testing and refinement in an advanced wind tunnel. It's a theory that a driver may not want to risk his life on.

At the moment, the Sonic Wind isn't much more than its parts laid out where they'd be positioned in what Stakes envisages as a seven-wheeled beast that's 14,4 metres long and 2,1 metres wide. Stakes gets help from friends in the land speed community, as well as the occasional moonlighting rocket scientist, but he alone is responsible for the design, hand-crafting the scale models and assembling the vehicle.

To any outside observer, Stakes's chances of completing his rocket car – much less breaking any records with it – might seem vanishingly small. It's tempting to remind him of the need for wind-tunnel testing, trained engineers – heck, even just a computer. But then, how many of history's breakthroughs sprang from the passions of similarly obsessed, deeply impractical men – the Wright brothers, Lindbergh, Cousteau... ?

Listening to Stakes spin out his vision of speed, you want to talk some sense to him, make him concede that he's in over his head. But then you don't. Does every dreamer need to build the first plane or fly the Atlantic? Is it so wrong to chase a dream that might truly be beyond your grasp?

Not long after POPULAR MECHANICS visited his tiny workshop, Stakes learned that his landlord was nearly doubling his rent. Undeterred, he simply packed up his parts, plans and prototypes to a small ranch he bought on the outskirts of Apple Valley, deeper in the Mojave Desert. He says he could have handled the rent, but actually prefers his new location. It's isolated, with fewer distractions, and he can work outside. But he won't be able to walk across the street for lunch at Del Taco anymore. "The best thing about working alone," he says, "is that you don't have to ask anyone to make changes."

PM

Smartphone cinematography

Cellphones (and flip-style cams) are the new camcorders. Here's how to get great video out of not-so-great hardware.

> BY JOHN HERRMAN



➔ The best camera is the one that you have with you.

It's a nice sentiment, and very often true: when it comes to capturing life's most important moments, a camera's first duty is to simply be there at the right time – everything else is a bonus. Flip-style cameras are small and easy to carry; smartphones, many of which are also serviceable video cameras, live in pockets and purses, perpetually within reach.

But there's a difference between documenting a moment and filming it. Too often, cheap video cameras and smartphones produce video that's shaky, washed out, improperly exposed and grainy. With the right tools and techniques, however, you can take your smartphone videos from good enough to, well, pretty good.

Camera compromises

Before you can overcome your smartphone camera's limitations you need to understand them. How, exactly, are these cameras different from a high-quality, dedicated camcorder? After all, both share the same basics – lens, aperture, sensor and software – and record at either 720p or 1080p. Yet they produce very different video.

The single most important difference between an HD smartphone camera and a more able HD camcorder or digital SLR camera is the image sensor. Whereas midrange camcorders house sensors that measure up to 15 mm diagonally and typical video-enabled DSLR sensors measure at about 28 mm, smartphone sensors tend to be much smaller. (The iPhone 4 uses an 8-mm sensor for photos and video, and that's on the large side for a phone.) The reason this matters is simple: a sensor's job is to collect light, and it's easier to collect light over a greater surface area. As a result, smaller sensors must be extremely sensitive to light, which reduces colour quality, increases image distortion and results in jarring, multicoloured speckling, known as image noise.

The second major limiting feature of a cheap camera is its lens. Rather than the generously large zoom lenses found in camcorders and DSLRs, phones and pocket cams have small, fixed optics. Typically these are neither very sharp nor particularly good at letting light reach the sensor; worst of all, they can't zoom (digital zoom doesn't count).

Sensory tricks

Marty Martin, a director and cinematographer, is accustomed to shooting in professional scenarios with professional-level gear. Yet almost immediately after the launch of Apple's smartphone, he used it to record a music video for his friend Steve Fallows (aka flakjakt). "Since I first dove into filmmaking I always kept one piece of advice in mind," Martin says. "It's not about the instrument, it's about the person behind it."

The resulting video was impressive, but to Martin the camera's limitations were immediately clear. Above all, he remembers struggling with rolling shutter, a phenomenon that causes a rippling effect in videos. This is because the sensors used in smartphone cameras record by scanning each frame from one side to the other in a

sweeping motion, rather than snapping the whole frame at once. If something in the frame is moving quickly – or, more likely, if the whole frame is moving as the result of a shaky camera – the image expands and compresses in conspicuous ways. (Use your smartphone to take a close-up video of a guitar string or a spinning fan for an extreme example of this effect.)

To avoid the rolling-shutter effect, stabilise your camera. If possible, keep the camera absolutely still by resting it on a fixed mount. Many flip-style cameras feature tripod mounts, so investment in a cheap miniature tripod or monopod is well worth it. Devices like the Joby Gorilla-

Pod double as grips, preventing the vibrations and twitches that are so apparent in freehand-shot videos. Smartphones lack tripod mounts, but cases can be purchased to add 6 mm screw mounts to many common models. (The following page offers some DIY alternatives.)

For his friend's music video, Martin took stabilisation to the extreme. "I really limited the range of movement," he says, which was key to the success of his video: the majority of the footage was shot from a static mount, which rendered the rolling-shutter effect unnoticeable – and gave the impression that the video had been



IMAGE PROBLEMS

SMARTER SMARTPHONE VIDEO

OVEREXPOSURE The sky is white when it should be blue.

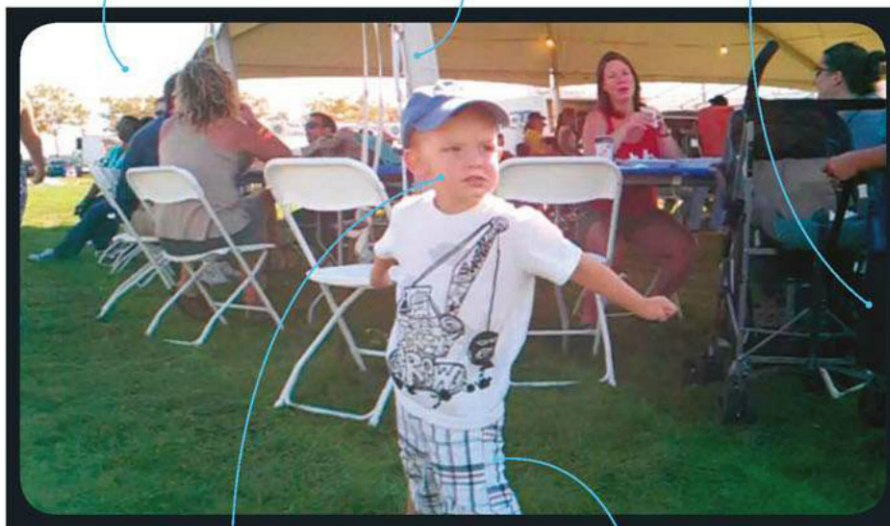
SOLUTION If possible, shoot on an overcast day. If inside, don't aim at a light source.

ROLLING SHUTTER Tent pole appears bent; areas of photo look compressed.

SOLUTION Stabilise the camera, or move it more slowly.

IMAGE NOISE Areas in the shadow are grainy.

SOLUTION Ensure even lighting, or apply noise reduction in an editing program.



COLOUR TEMPERATURE Little boy's skin is strangely tinted.

SOLUTION Ensure multiple light sources are the same colour.

POOR FRAMING He's also awkwardly centred.

SOLUTION Learn and abide by the rule of thirds; move subject to left.

shot with a much better camera. If you absolutely must shoot freehand, and without any kind of stabilising accessory, there are a few rules to follow. Hold the camera with both hands and grip it firmly – a tentative touch inevitably results in shakiness. Move slowly, turning the camera with your whole body rather than your wrists; fast movements don't translate well with almost any camera, but cheap ones amplify the problems.

Lastly, if you're using a smartphone, turn the handset sideways. It will be easier to hold steady and ensure that your video is shot in the correct aspect. A video can look only so good with giant black bars on either side.

Indecent exposure

Cheap lenses and straining sensors make getting an even exposure on a low-end camera difficult. Smartphones' highly automatic shooting modes mean that it's often easier to control your environment than it is to control your camera settings.

Shooting outside is best done on a cloudy day or in the shade. Cheap camera sensors have a low dynamic range, which means that they are unable to record drastic variations in light in a single frame. Too much light will overwhelm the camera, with bright skies or reflections causing the rest of the frame to be underexposed. If the glaring Sun is unavoidable, shoot from an elevated vantage point. This will ensure that the sky is mostly out of the frame and allow the camera to meter your subject, not the sky, for its exposure.

Shooting indoors affords you more control, but introduces new problems. Don't light your subject from behind or from directly in front; use diffuse lighting (a lampshade) where possible, or light from the sides. In any case, make sure there's enough illumination – cheap cameras perform poorly in low light. A humble shop light bounced off a ceiling or wall, for example, can turn a shadowy scene into a tastefully lit one.

You'll also need to account for light colour. Cameras automatically adjust to compensate for the colour, or temperature, of a light source – natural light is very cool, whereas many household lights are very warm. An open window near a shining lamp may leave your subject with a yellow or blue tint, depending on which light source the camera focuses on.

The basic rules

Some rules apply to all camera types. Pay attention to how you frame your subject, and don't always go for the obvious shot. Respecting the rule of thirds, which divides a frame into a 3 x 3 grid, will help you compose more interesting shots. Try placing your subject somewhere other than the centre of the frame.

Anticipate your subjects' actions and give them space to move; likewise, if someone is facing to the left or right, move him to the opposite side of the frame. If you can't fit a subject's entire body in a shot, crop at a natural cutoff line, such as the elbows, knees or hips. For further stylistic guidance, Martin recommends an impromptu apprenticeship with the many talented videographers who post work online: "Do some research on Vimeo (a community for original video). Look up beautiful home videos of subjects you like, and spend a few minutes figuring out what makes them good."

Video editing has become extremely simple with the advent of user-friendly editors such as iMovie and Windows Live Movie Maker and can help polish a decent video, or salvage a bad one. Your first impulse when shooting with a smartphone may be to record snippets and avoid editing altogether. You're always better off overshooting and cutting later. You have gigabytes of space to record with, and besides, the only way to make sure you don't miss the pivotal moment of your kid's soccer game is to keep the camera rolling. Editing out a fumble or a face-plant takes just a few seconds, but you can't edit in something you didn't film.

PM



CAMERA BAG DIY

BUILD YOUR OWN ACCESSORIES

Using a smartphone as your primary video camera isn't solely about convenience – it's about saving money by getting the most out of a gadget you already own. Here are three ways to save money on accessories, too.



THE 20-CENT MOUNT

Smartphones don't have tripod mounts, but making one is easy. Cut a paper or Styrofoam cup in half, then cut two phone-size slots in the bottom half. Punch the tripod's mounting bolt through the bottom of the cup, then tighten a nut over the washer.



THE STRING LOOP

Keeping a smartphone stable and vibration-free is close to impossible without some help. A loop made from 3 metres of string or twine wrapped once around your phone's body lets you stabilise your shots against tension provided by your foot.



THE HANDI-CLAMP GRIP

For a more mobile stabilisation option, a cheap, rubber-padded hand clamp can serve as a secure grip for a smartphone. Clamp with care – too much pressure can damage the screen. Best used in conjunction with a sturdy case.

All-New **RANGER**



147 kW
POWER

Surpasses global
emissions standards

470Nm
TORQUE

Take on the African outback, without destroying it.



THE MIDDLE OF NOWHERE.



* Model shown with optional sports bar

Feel the difference

EYES... WRONG

Eyewitness accounts have long been regarded as less than perfect. Although we can improve on them, a psychology academic says, we shouldn't always believe what we see.

BY ANTHONY DOMAN

We're all familiar with the expression, "I couldn't believe my eyes."

In fact, it's long been known in psychology circles that the eye is anything but a reliable witness. It's even less reliable when combined with memory. Yet our reliance on eyewitness testimony has sent hundreds of innocent people to prison. The implication is clear: we shouldn't believe our eyes (within reason, of course).

But the fact is, our ability to recall what we've seen – particularly whom we've seen – should be treated with suspicion.

University of Cape Town psychology professor Colin Tredoux has a deep interest in how our eyes perceive. And how, in large measure, they can deceive.

In his inaugural lecture, *Pragmatic psychology and the perils of eyewitness identification*, Tredoux pointed to perceptual pitfalls in the criminal justice system that had the worst possible consequences: they simply put the wrong people in prison. Not only was this shockingly inappropriate, it also left the real criminals out on the streets.

"The testimony of eyewitnesses has long been of considerable importance in criminal cases," Tredoux notes. Important as it may have been, this testimony could lead to "terrible travesties of justice".

There are also difficulties in certain circumstances. According to legal precedent, in the event of a single eyewitness judicial officers are enjoined to "proceed with caution". But a problem arises, says Tredoux, in a case such as rape. "There is just a single eyewitness."



Who, me?

Clearly guilty

*He's the one
you saw*

PROOF POSITIVE?

NOT GUILTY: In 19th-century London, Norwegian Adolf Beck was mistakenly identified as a conman and imprisoned for years.

NOT GUILTY: The Eikenhof Three were imprisoned for murdering three people in 1993. They were released in 1999.

GUILTY? A dubious police line-up and confession helped put away Cape Town's Station Strangler (alongside, top left, with artists' impressions). Important DNA evidence was excluded.



Figure 13 Face composite sketches made by eyewitnesses in the "Station Strangler" case

Fortunately, the advent of DNA profiling about 30 years ago helped provide a way of proving innocence – or at least proving reasonable doubt. The subsequent rash of overturned convictions not only confirmed what had been well known about eyewitness accounts – it also showed how pervasive the problem was.

In the USA, for instance, since 1990 a total of 273 prisoners have been exonerated on the basis of DNA evidence. They'd each been in prison an average of 13 years; 17 were on death row.

Face facts

Our ability to recall accurately depends on memory, perception – and an unfortunate propensity to suggestibility. We are quite easily persuaded, apparently.

Complicating matters when trying to remember faces is the fact that they are different, both individually and regionally. "Face populations are specific," Tredoux explains. South Africa, for example, has a wide range of facial types. "Cape Town is very diverse. We are certainly more diverse in Cape Town than most US cities."

Recognition is coloured by "own group bias". It is strongly regional, and has to do with the perceptual history of the witness. Witnesses in the US will recognise their own group member more accurately than members of other groups, so much so that African Americans will recognise African Americans at a higher rate than Black Africans, and will recognise Black Africans at the same rate as White Americans.

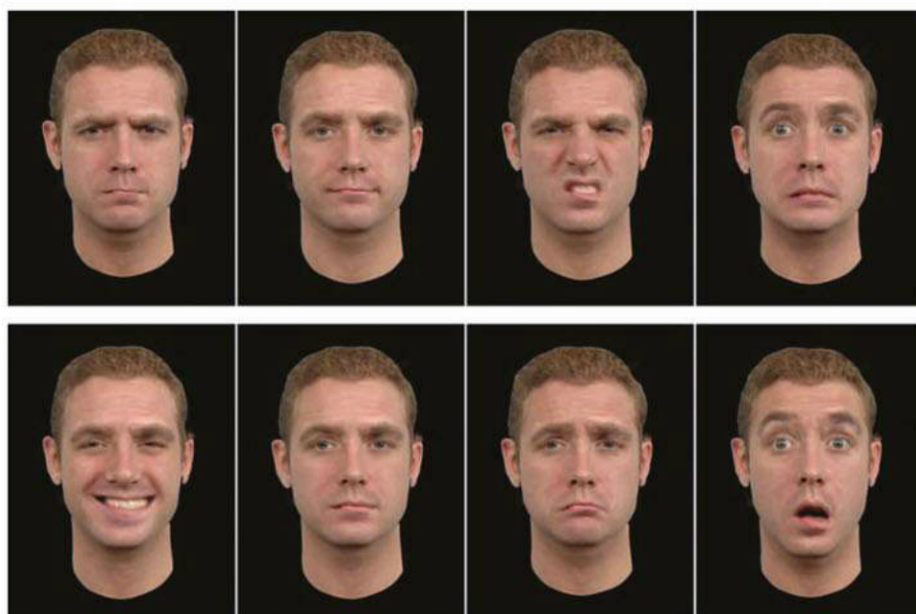
Fair or foul?

Tredoux is particularly interested in recognition and perception as they affect police line-ups.

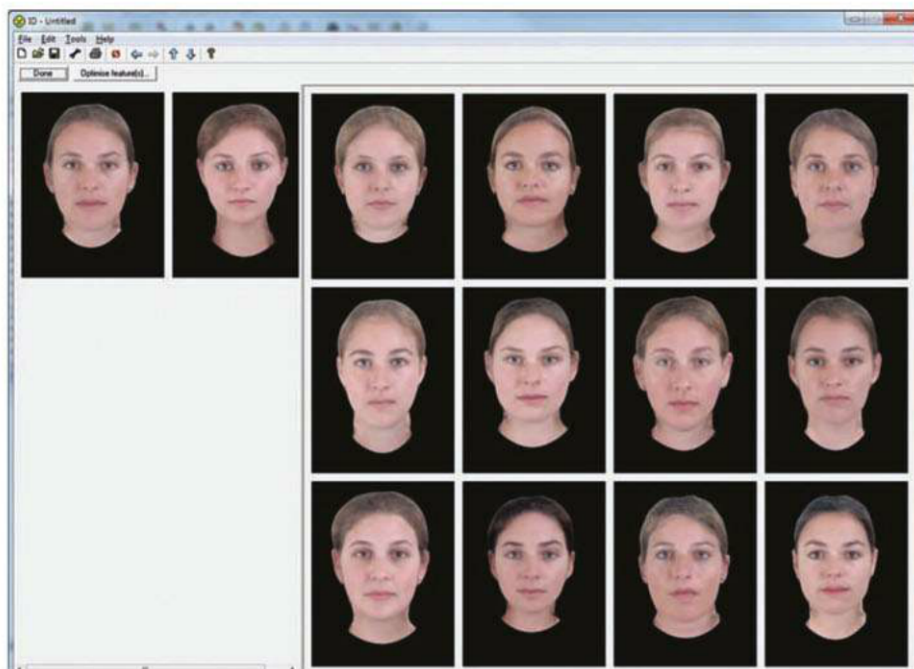
What troubles him about line-ups is their fairness. Essentially, suspect and foils – the others brought in to fill up the line-up – should look like each other. "Some of the problems (preventing fairness) are undoubtedly perceptual, but some of them are situational," he says. "The way they interview, to take one area, is not optimal. The police are quite stretched." Practically, that involves the difficulty of locating suitable foils. (It's given rise to a minor industry involving an enterprising supplier who provides foils on request for US police line-ups.)

It is not purely what we think we witness that can potentially send an innocent to prison. It's also partly the fault of the way the criminal justice system goes about its business.

"Police are by nature very suspicious," Tredoux says. "They look for confirmatory evidence." In other words, they are looking for evidence to convict a suspect



Software is able to add expressions to faces as an aid to identification and recognition.



Eigenfaces, derived largely from statistical analysis, can be used as virtual equivalents to a real, live line-up to achieve a dual objective: avoiding the bother of finding suitable "foils" and ensuring fairness with faces that are sufficiently similar.

not to exonerate or exclude suspects.

Scientists, on the other hand, approach things from the opposite point of view. "The standard for scientific enquiry is to try to find 'disconfirmatory' evidence." However, he is sympathetic to the police. "You can hardly blame them."

In the real world, perhaps rigorous scientific standards are more applicable to the laboratory situation. Faced with a need to find a guilty party, and with the knowledge that, in South Africa, many guilty people go free, they would be inclined to pursue

a confirmatory agenda.

But, even with that mindset, he says, there are ways of lowering the margin for error. Tredoux combines psychology, statistics and computer science to create a "virtual" line-up using computer-generated pictures – eigenfaces – instead of flesh-and-blood people. These incredibly lifelike eigenfaces are derived from statistical analysis and can be combined to create new faces with characteristics weighted more to one facial type than another, as needed.

To catch a killer

One celebrated case involving a line-up that has exercised Tredoux's mind in recent times is that of the Station Strangler. This serial killer was said to have been responsible for more than 20 sex-related murders in the Cape Peninsula.

"I had a copy of the line-up video for many years," Tredoux says. It didn't get much play, though. "I never looked into the case in much detail until the reports a couple of years ago," he explains. Local news media revived the story on the back of renewed interest in such cases because of campaigns, started in the US, aimed at finding out if people who claimed they had been unjustly imprisoned were genuine.

"If you see the video... the disparities are quite dramatic," he says. Viewing the video with Tredoux in his office at UCT, one thing at least stood out, even with the poor quality of the visuals: the clothing worn by Avzal Simons, the man eventually convicted. The person pointed out as the Station Strangler is dressed significantly differently to the others in the line-up.

According to Tredoux, Simons was the only one with a facial scar, and the person who supposedly pointed out Simons said simply that he looked most like the alleged killer. DNA evidence for other supposed Strangler victims could not be used. "The defence was trying to get the DNA evidence admitted."

Simons was eventually convicted on the "standard 2-pack" of eyewitness testimony and his confession – a confession, says Tredoux, that was clearly "the rambling of a crazy person".

Born to recognise

Here's the thing: we have an expertise for faces.

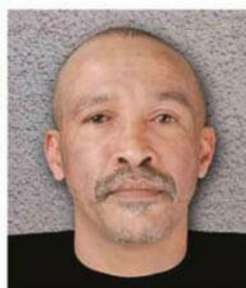
"It's evolutionary," says Tredoux. "We start learning to recognise faces from birth. Within a short time after birth, a baby will recognise even a cartoon face as a face, and not just another picture. So you start acquiring that expertise early."

A specific area of the brain deals with that facial recognition. "There is no mystery what area of the brain it is: it's called the fusiform face area." In populations that struggle with faces (for example, autistic people), scans of their brain show that they are not using that area.

What we mean when we say that we recognise a face is that we recognise configurations of features. This is an involuntary process and it's also contextual – it depends on where we are seeing the face. That's why we often have difficulty placing a face of somebody seen out of context; say, somebody from another part of our office building whom we don't recognise at the gym.



1



2



3



4



5



6



1



2



3



4



5



6

Top: software-based "Identikit" – but only one of these faces is real; the rest are spun off the original, picked out of the original six shown above.

It may seem stating the obvious, but it is worth noting that unfamiliar faces are easily changed by disguise, but not so with familiar faces.

Do people see what they want to see? "Yes, suggestibility is intense," he says. That is as true for spirit mediums' suggestions as for everyday occurrences.

An important part of the cognition process is memory. The bad news is that there is truth in the old saying, "get yourself a teenager now while they still know everything".

"The memory curve reaches its peak in the teens," Tredoux says. "There is a sharp decline from the late 40s." This decline can

be arrested by means of mental exercise – even everyday activities such as crossword puzzles.

Of course, for as many of us who want to remember and recognise, there will be those who wish to escape detection. It could be as simple as changing the more obvious external features: the logical place to start is to change your hair, Tredoux says. "You can make it longer or shorter, or style it. And you would work your way inwards – shave or grow a beard."

And here's another tip: avoid people who do crossword puzzles. **PM**

● (Includes material from UCT's Monday Paper)

NEW ON THE BLOCK

Headlines from around the automotive world >>>

COMPILED BY ANTHONY DOMAN
anthony@ramsaymedia.co.za

NISSAN JUKE

URBAN ATTITUDE

There's nothing conventional about Nissan's approach to crossovers: the Murano and Qashqai demonstrate that sporty and spunky can work just as well as staid and stoic.

Now the company says that it has created an entirely new niche – the Sports Crossover, in the compact B segment – with the Juke. Practically speaking, it's a grown-up hatchback with SUV functionality and sassy attitude.

What is surprising about the Juke is its punchy performance and agility. The quirky looks shout "SUV", but the Juke doesn't suffer from the roly-poly dynamics and moderate around-town drive that beset many smaller-engined vehicles of this type. If anything, it is more of a sportster with styling that leans heavily on SUV styling, while hinting at areas such as rallying.

It's also a showcase for some cutting-edge tech. For one thing, the new direct-injection turbo engine is the first dual-injector design in mass production. There's also the advanced I-CON command system, which incorporates an adjustable info-graphic display that changes its displays, colours and functions depending on the chosen driving mode.

The interior styling is even more adventurous than the outside's: the gleaming centre console is said to have been inspired by a motorcycle fuel tank. It's practical, too, with 251 dm³ boot and split folding rear seats.

The naturally aspirated 1,6-litre engine features a pair of injectors per cylinder with smaller-than-usual nozzles to deliver finer control of fuel delivery. Power is 86 kW, up 6 per cent over previous versions of this engine; torque (157 N.m) is up 3 per cent. Combined cycle fuel economy is 5,6 per

cent better at 6 litres/100 km.

The turbocharged and inter-cooled DIG-T engine option produces 140 kW and 240 N.m of torque. That's good, says Nissan, for a 0-100 km/h sprint in 8 seconds with 6-speed manual gearbox. Economy is rated at 6,9 litres/100 km on the combined cycle.

On front-wheel drive versions, suspension is by MacPherson struts at the front with a torsion beam at the rear; four-wheel drive models use a multi-link rear suspension similar to the Qashqai crossover's. What Nissan describes as a world-first in small cars is the new rear axle on 4x4 versions, which incorporates electronic couplings at either end. It's lighter and smaller than rival designs.

Prices start at R198 000 for the 1,6 2WD Acenta model in manual transmission, including a 3 year/90 000 km service plan.





TWO SIDES OF A COIN

2012 TOYOTA AURIS

Same car, two very different approaches. The HSD is the first application of hybrid tech in a mainstream Toyota, whereas the TRD ups the ante for performance hatchbacks by strapping on a supercharger.

Auris TRD

Petrolheads still get all misty-eyed when the talk turns to the snorting rear-wheel drive Corolla Liftback 1.8 TRD that provided the brand with a certain swagger in the 1980s. Although Toyota Racing Developments – the company's performance and motorsport brand – has had limited exposure in this country, it has gained a firm foothold in many other parts of the world. For those who felt deprived as a result, Toyota SA has put together a racy limited edition package of just 200 models based on the Auris Sport X hatch.

To the 1.6-litre Sport X with 6-speed transmission is added a traction-drive supercharger that boosts power by 36 per cent (from 97 kW to 132 kW at 6 400 r/min) and torque by 27 per cent (from 160 N.m to 203 N.m at 5 200 r/min). From standstill to 100 km/h now takes about 9 seconds, and top speed is 220 km/h. Fuel consumption is 7,5 litres/100 km.

Running gear is modified to match, with ride height dropped by 35 mm and a TRD suspension set fitted, comprising shock absorbers, springs and coil springs. Let's go racing...

Thar she blows: centrifugal, traction-drive supercharger vs turbocharger.

Toyota says its decision to opt for a supercharger was based on the need for good engine response across the rev range, similar to that of a normally aspirated engine, without the dreaded turbo



lag. Good catalyst warm-up when starting from cold avoids the sometimes adverse emissions of a turbocharged engine; the TRD engine emits 180 g/km of CO₂. On a practical level, the company says, the supercharger provides a light, compact and cost-effective power boost, with no need to remove the engine for installation.

Auris HSD

The hybrid combines torque output of 142 N.m from its 1.8-litre Atkinson cycle petrol engine with 207 N.m from its electric motor to provide bracing yet planet-friendly performance, in an arrangement similar to the one used in the Prius.

Powered by the hybrid battery and automatically integrated into the powertrain by the drive management system,

the electric motor can boost petrol engine performance or be used to drive the car entirely on its own in EV mode.

During deceleration and under braking, the electric motor switches into generator mode to provide regenerative braking for recharging its battery.

Average fuel consumption figure of 3,8 litres/100 km and CO₂ emissions of 89g/km are quoted for the Auris XS HSD fitted with 15-inch alloys.

Look closely and you'll be able to spot a few exterior details that mark the HSD as a rather different Auris (besides the badge, of course). It's all about drag efficiency, naturally. Aero tweaks to the front bumper and spoiler, and a larger lower grille, reduce drag and improve engine cooling. The upper grille's single chrome blade design is specific to the HSD.

Reshaping the corners of the front bumper not only sets up a new foglamp configuration with LED running lights (also unique to the HSD), it also redirects the airflow over the front wheels, minimising wheelarch turbulence. Finally, the car rides 5 mm lower than its siblings. In total, the coefficient of drag has been cut from 0,293 to 0,283.

Prices start at R267 200.

TOYOTA YARIS A NEW MATURITY

Viewed side by side with the new model, the previous-generation Yaris looks cuter. But the new one looks more grown up. That's probably more appropriate these days for a product line-up that starts with the offbeat Aygo and will soon acquire the more budget-oriented Etios. It's also a reflection of Toyota's intention to aim the Yaris at more male buyers than before. The new Yaris is the first Toyota to feature the company's distinctive new family "face" incidentally.

For our introduction to the new Yaris, we drove out for a rare visit to Toyota's Eston test track in KwaZulu-Natal. On urban and country roads the 2011 Yaris underlines its predecessor's virtues of controlled, comfortable ride in a compact form factor. We also had the opportunity to try out the Yaris on some of Toyota's test routes – notably a short off-road rally-stage section and a high-speed stretch. Both of those were despatched in style. Driven vigorously around the gravel route, the Yaris showed impressive composure and, again, that ride control. Taken through a simulated emergency lane change at 120 km/h on the high-speed track, the little Toyota gained approving nods for its superb stability.

A slight increase in wheel-base is matched with shorter overhangs front and rear, so that the new car is 100 mm longer than before. It retains its handy 9,4 m turning circle.

A more driver-oriented approach to the interior includes new analogue instrumentation that's been moved from the centre of the dashboard to ahead of the driver. There's a significant increase in rear seat space, partly thanks to thinner front seat-backs. Adopting a similar approach to the rear seat-backs, Toyota says luggage space has increased by a massive 49 per cent to 347 dm³. That's backed up by a formidable array of interior storage spaces.

Both powertrains are rated Toyota Optimal Drive, incorporating engineering, weight-saving and aerodynamics to help cut fuel consumption and emissions while maintaining power and torque outputs.

At entry level, the familiar thrum of the 1,0-litre three-cylinder is retained, albeit with some improvements. With new pistons designed for a higher compression ratio, it develops 51 kW at 6 000 r/min and 93 N.m at 3 600 r/min; fuel consumption is 6 per cent better at 5,1 litres/100 km on the combined cycle. Significantly, CO₂ emissions are down by

6 per cent to 119 g/km, below the emission tax threshold.

Upscale versions get an all-new long-stroke 1,3-litre Dual VVT-i engine that produces 73 kW and 125 N.m. Although a 6-speed manual is standard, when mated with the optional CVT transmission, fuel economy and emissions are noticeably better. The CVT features 7-step operation and manual override, operated by either the

gearshift lever or paddle shifts on the steering wheel. In fact, says Toyota, overall the new Yaris is the most fuel-efficient model line-up in the B segment. (Eco features include a gear-shift indicator that communicates to the driver when to change gears for best consumption and, on the CVT version, an Economy Meter and an Eco Indicator.)

Besides an inherently secure design that's been suitably rewarded with high scores on the Euro NCAP crash test programme, the new Yaris is available with up to seven airbags, and the suite of driver aids ranges from ABS to Brake Assist, Electronic Brakeforce Distribution (EBD) and Stability Control (VSC), depending on model.

Prices start at R124 000, including a 4 year/60 000 km service plan.



When you think about it, a car is just a means of getting from Point A to Point B. The way each individual model accomplishes that, of course, is what makes it special – or not. That's why, every year, our colleagues at Popular Mechanics USA pick what they consider to be the finest examples of the automotive art. These awards recognise cars that are technologically advanced, tremendously good value, enormously capable, or just plain fun to drive. We present the ones you're most likely to see on South African roads. (Or off them, for that matter.)

Sometimes personality trumps style – just ask us about the BMW 1M. It's the least expensive of BMW's mighty M cars... and the least pretty. The flared fenders and gaping mouth tacked onto the base 1 Series make it even chunkier, not sleek and lithe like a typical sports car. But we still clutch the keys like a toddler with a lollipop. There's a surplus of performance – a turbocharged 250-kW straight-six engine, mammoth tyres and brakes, and stiffer suspension – but speed is not the main thrill.

The other subjective measures, such as perfectly linear brake action, steering that feels hard-wired to your brain, delicate road signals communicated through the seat, and the creamy six-speed manual transmission, all combine for a dynamic delight. And it's those traits that separate simply fast cars from the truly rewarding ones.

The 1M is simultaneously ferocious and controllable, a machine that doesn't neuter the driver with safe but boring handling. It



• FUN TO DRIVE

2012
BMW 1M
COUPÉ

nudges you to explore that outer edge of speed and control, and then brings you safely back. After a day or so behind the wheel, it's all too easy to believe the fantasy that you're fit for the Monaco Grand Prix.

The 1M is not a car that simply gets you from place to place; instead it seduces you into taking the long route to your destination just so you can exercise its talents a little longer.

• TECHNICAL INNOVATION

MAZDA
SKYACTIV
ENGINES



PETROL
ENGINE

Mazda's new SkyActiv petrol engine is a perfect example of small and creative improvements combining for a significant efficiency gain. Take, for example, the motor's compression ratio, which at 13:1 is about 20 per cent higher than that of most other engines. Higher compression means the engine gets more work out of each combustion event, but it also increases the risk that the air-fuel mixture will auto-ignite, a harmful condition known as detonation. To reduce that risk, Mazda employed direct fuel injection and an elaborate exhaust header with equal-length pipes running from the cylinder head to the catalyst. Both reduce heat – the fuel cools as it evaporates and the header scavenges the hot exhaust gases.

There's also a new twist on the variable valve timing mechanism. The intake cam's actuator can rotate 180 degrees – 40 is typical. So when full engine power isn't needed, the computer can leave the intake valves open during a portion of the compression stroke, which reduces the amount of air – and thus fuel – consumed by the engine. All these features, plus careful attention to reducing friction and weight, yielded a normally aspirated 2.0-litre engine that produces 118 kW and should return 6 litres/100 km when it debuts in the Mazda3 next year.

SKYACTIV DIESEL ENGINE

Diesel engines are wonderfully efficient, but they require costly urea-injection systems to match petrol-engine exhaust emissions. Mazda's new 2.2-litre diesel, however, meets all US regulations, without urea injection. Plus, when it arrives in 2013 in the CX-5, it will produce around 420 N.m of torque and rev to an un-diesel-like 5 000 r/min.



DIESEL
ENGINE

THE WRANGLER'S
ALL-TERRAIN ANATOMY**ENGINE**

The new 3,6-litre V6 produces 213 kW, which is 62 more than last year's, yet is 21 per cent more fuel-efficient. An aluminium block saves 40 kg over the old iron 3,8-litre.

FRONT AXLE

No independent suspension here. The rigid axle is tough and can be optioned with an anti-roll bar that electronically disengages so the axle can freely rock and follow rough terrain.

TRANSMISSION

The five-speed automatic has a wider ratio spread for better fuel economy. The six-speed manual is still available.

TRANSFER CASE

Once engaged, the transfer case sends power to the front wheels. Rubicon models offer a ridiculously low 4,10:1 low-range ratio so they can inch along slower than a walking pace and gingerly crawl over obstacles.

REAR AXLE

Drivers can outfit the Wrangler with one of three final-drive ratios to enhance either fuel economy or low-speed crawling ability.

● OFF-ROAD ABILITY

2012
JEEP WRANGLER

The constant struggle for Jeep is civilising the Wrangler without killing its off-road prowess. After all, no matter how capable it may be on the Rubicon Trail, a scant few customers are willing to endure a choppy on-road ride or an interior racket that sounds like a snare drum in an oilcan. In the past 18 months, the Wrangler has nearly been upended. The designers ditched the granite-hard interior for one with softer materials and gentler curves. They redesigned and thickened the soft top to reduce wind noise. A more powerful and efficient driveline replaced the ancient 3,8-litre V6 and four-speed automatic. The new Wrangler, which is available with two or four doors, is the most livable ever. And it still has the steep approach and departure angles, stout running gear and hardware – skidplates and locking differentials – that make it the most capable off-roader available. Many vehicles can take you to remote locations, but you're most likely to make it back home in a Wrangler.

PM



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NON-POLLUTING HIGH-FLYER

Electric multicopter

In a claimed world first, a bunch of very smart techie types from Karlsruhe in Germany has designed, built and actually flown the electrically powered e-volo multicopter – and here's the photographic evidence. Brainchild of Thomas Senkel, Stephan Wolf and Alexander Zosel, the lightweight e-volo is equipped with four jibs, each featuring four propellers, and carries a maximum payload of 80 kg.

What makes this flying machine rather special is its ability to “park” in the air, using a GPS to pinpoint its desired position. It's safe, too: apparently it can be landed without a problem even if up to four of its 16 motors are malfunctioning. Its designers reckon the e-volo would be perfect for rescue or fire-fighting duties, explaining: “It goes up like a lift and stays still in the air.”



VIDEO

> Watch the world's first manned flight with an electric multicopter on www.popularmechanics.co.za

LIGHT UP YOUR LIFE – WITH BUGS

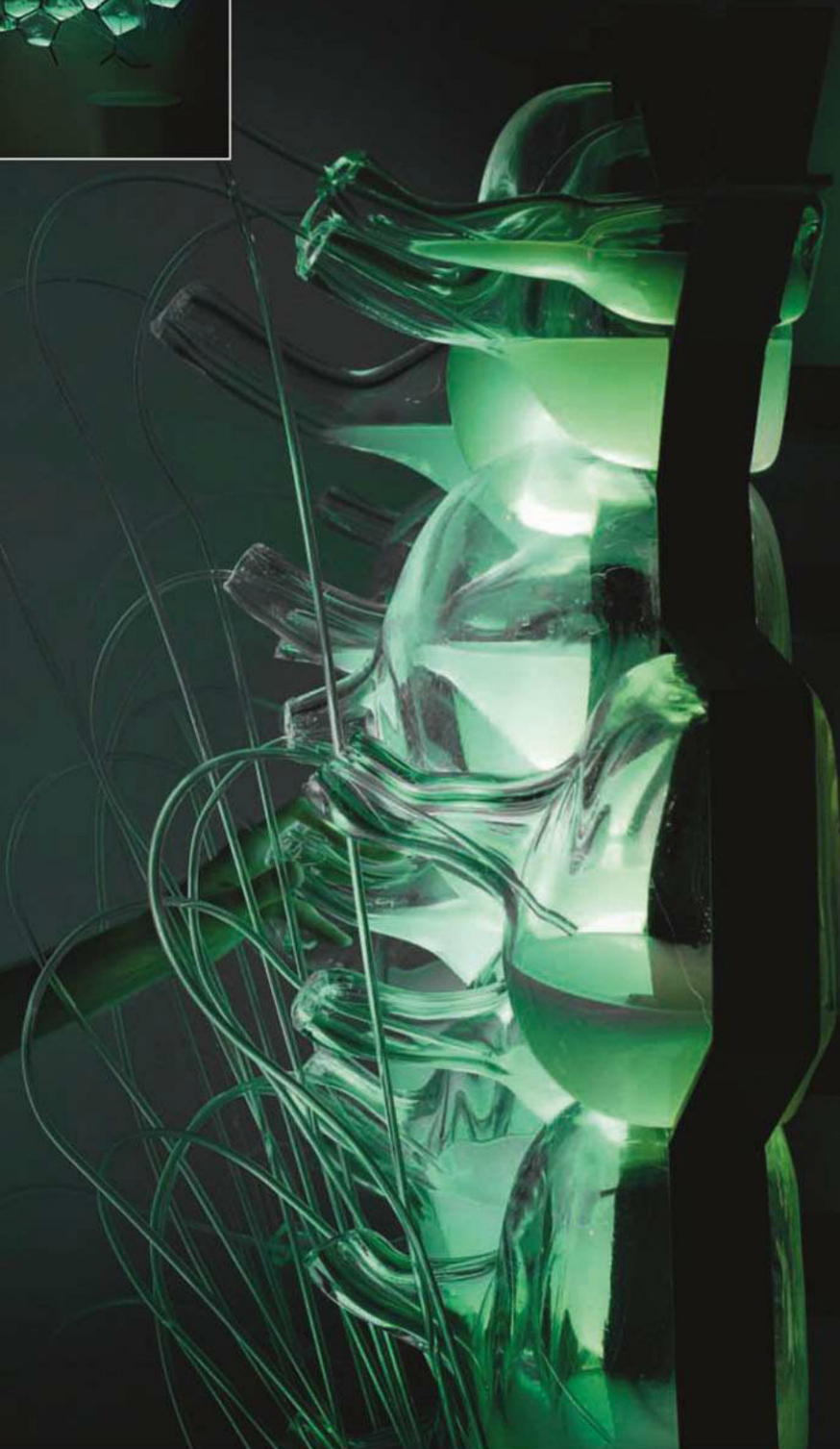
Philips bio-light

The search for greener, more power-efficient lighting systems won't stop with compact fluorescents and LED systems if Dutch electronics giant Philips has anything to say about it. In an effort to embrace a truly natural approach to lighting, the company took a cue from fireflies and deep-sea creatures to create a (literally) green light powered not by electricity or sunlight, but by glowing bioluminescent bacteria.

As one of numerous systems in its Microbial Home (MH) concept, Philips tasked itself with creating a lighting system driven by the wastes typically generated in the average home. To feed the bacteria housed in the bio-light's unusual hand-blown glass compartments, methane – which could be generated by the MH kitchen's bio-digester unit from composted bathroom solids and kitchen vegetable waste – is piped in through thin silicon tubes connected to a reservoir at the base.

Light produced by bacteria, or *luminescence*, is heat-free in contrast to *incandescence*, which is light generated by objects heated to glowing. A similar form of light, *chemoluminescence*, is given off by the familiar snap-and-shake glow sticks (a mixture of phenyl oxalate, fluorescent dye and hydrogen peroxide), but those are closed one-use systems with a limited light-production period.

The bio-light's living bacteria, on the other hand (which utilise the enzyme luciferase, and its substrate, luciferin, to generate light) can be driven indefinitely as long as key nutrients are supplied. While the light given off isn't bright enough to fully replace artificial light just yet, it's definitely a step in the right direction, especially because it gets people thinking about untapped household energy sources ripe for the plucking. Along with providing interesting, grid-free ambient light around the home, Philips envisions numerous other uses for its bacterially driven lights, including warning strips on curbs and steps, exit signs in low-light entertainment venues, and perhaps even night-time edge indicators for roads and highways.





HEY, WHY SLUM IT?

EleMMent Palazzo

Are you financially secure? Ready to go wherever your mood takes you? Here's one way to outshine anything on the road – and then some. It's the EleMMent Palazzo (don't you hate names that employ a mix of upper- and lower-case letters?), a futuristic mobile home equipped with an array of over-the-top luxuries that would make Donald Trump envious.

For starters, it comes with a fully automatic "flybridge" lounge, two floors, a master bedroom with bathroom en suite, remote video access, a lounge that transforms into a bar at the press of a button, and all manner of computer-controlled gadgets that turn your journey from A to B into something quite special.

PM





Celebrating innovation in energy efficiency: the 22nd annual *eta* Awards, sponsored by Eskom

Efficient by design



Seeing is believing

Knowledge is power. This holds the key to a smart device that could help South Africa achieve its energy-saving targets. Knowing your household's energy load instantly – via a very visible display – leaves citizens not only empowered, but also inclined to change their consumption habits. Potential savings could be as high as 10 per cent.

That's the view of **Paroshen Naidoo** from Midrand-based Utililabs, the overall winner in the 2011 Eskom *eta* Awards Innovation category for its smart Utility Load Management System.

Because of a lack of understanding of how and where to apply energy-saving tactics in the home, people aren't motivated to try. However, studies have shown the beneficial effects of giving real-time insight into a household's consumption levels. When we can immediately see how consumption drops on unplugging an appliance, we become more conscious of the impact of our energy use. We will probably also be more inclined to look for energy-efficient appliances.

In addition to empowering individuals, Utililabs' Utility Load Management System provides municipalities with monitoring, analysis and communication tools that help to optimise efficiencies and processes. Result: better customer service.

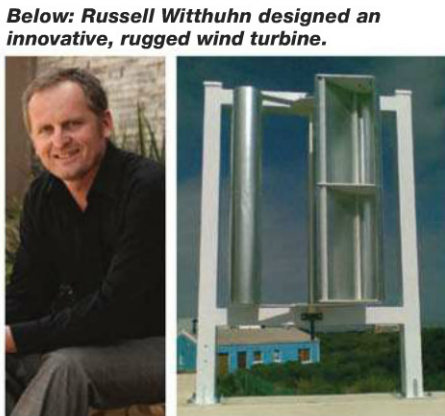
A vital part of the end-to-end system is the Eddi (Electricity Demand Display Instrument). This clever, plug-and-play device monitors and accurately displays a household's electricity consumption (and indicates supply constraints) in real-time. It is non-invasive and fits into any three-pin socket.

The fully locally developed and manufactured system, which has been patented in South Africa, the USA and UK, is being used by 14 000 customers in various municipalities. The goal is to get four million of South Africa's electricity-using households on to the system.

"With just 2,5 million people on the system, actively employing meaningful behavioral tactics to save power in their own homes, we could save the equivalent of a whole power station," says Naidoo.



Above: Themba Gama and Paroshen Naidoo of Utililabs, winner of the Innovation category for its smart utility load management system, right.



Below: Russell Witthuhn designed an innovative, rugged wind turbine.

Winds of change

A quest for a simple, clean and reliable alternative to existing wind turbines for his own home – and regular power outages – prompted a Betty's Bay engineer to develop a robust, compact design that has earned a runner-up award in the Eskom *eta* Awards.

According to **Russell Witthuhn**, his innovative, Tri-Aero Blade Turbine generates 1 kW per hour in a stiff breeze and works even in low winds. Built of robust galvanised steel and powder-coated, the wind turbine is designed to withstand harsh local conditions, yet is noise-free, with negligible vibration.

Besides being able to meet the energy needs of an average household fitted with a solar geyser and gas stove, it can also be adapted to feed into the power grid.



Meinhard Fourie's energy-efficient pool pump could save 3 kWh daily.

Draining pool pump energy costs

An energy-saving pool pump motor has earned **Meinhard Fourie**, an energy expert from Cape Town, runner-up status in the Innovation category of Eskom's 2011 *eta* Awards.

The approximately 0,6 GW of energy consumed by the pumps of South Africa's 1 million swimming pools is enough to power 500 000 average households.

After two years of development, Fourie has devised a pool pump that achieves a saving of approximately 3 kWh a day, without compromising on the typical 10 – 12 hours a pump is expected to run.

More about the *eta* Awards

The prestigious annual *eta* Awards, sponsored by Eskom, are aimed at recognising excellence by individuals and companies in the field of energy efficiency. To find out more about how you or your company can enter the *eta* Awards, visit www.eta-awards.co.za

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Embracing our INVENTIVE FUTURE

Here's an encouraging fact: despite everything we've been told, South Africa remains a rich repository of inventive talent. In fact, pockets of genius lurk in some unlikely places. We know, because we've seen them.

Our **INVENT 2011** initiative, comprising the third annual Inventors Conference and the inaugural PM Inventors Competition, is done and dusted – and by all accounts, it worked. Our delegates were treated to a line-up of compelling presentations, everyone learned something new (ourselves included), and we emerged from a nationwide inventors' showdown with a bunch of undisputed and deserving winners.

Topping the list was University of Cape Town bioengineer Dr George Vicatos, named as Inventor of the Year for his development of a versatile and potentially life-changing facial reconstruction system. His R50 000 prize money included an award for top spot in the *Cutting Edge* category. The presentation was made at a black-tie ceremony in Johannesburg following the Inventors Conference. The judges remarked that Vicatos' invention "demonstrated his commitment to a better understanding of the human organism and the tireless pursuit of practical solutions for its frailties". Runner-up in this category was Gerard de Vaal of Cape Town, who developed and patented a revolutionary cooling system for LED products that could result in significant advances in the lighting industry.

Somerset West inventor and businessman Jamii Hamlin captured first place in the Going Green category (sustainable



Bioengineer, inventor and academic George Vicatos (middle), South Africa's Inventor of the Year for 2011, after receiving his award. With him are Motlatsi Nzeku, managing director of Telkom International, and Alan Duggan, editor of POPULAR MECHANICS.

energy/environmental conservation) with his versatile, ecologically sound and finely engineered Ecostake and Elektrostake stainless steel products for agricultural trellis and fencing applications.

No first prize was awarded in the Emerging Genius category, but Kagiso inventor Lucky Mokalusi received a Special Merit Award of R10 000 in acknowledgement of his work on a "virtual-reality training cycle", which employs an exercise bicycle coupled to a monitor and employing GPS data logger software to simulate real-world training routes. A similar award went to Mpumalanga inventor Kenneth Miya in recognition of his cellphone-based security system for domestic and other applications.

In the Science division of the Industry Awards, the Square Kilometre Array (SKA) project team was honoured for the "scientifically compelling and technologically inspiring work" underpinning South Africa's bid to host the world's most powerful radio telescope. The award was accepted by Willie Esterhuyse, project manager of the MeerKAT Array, precursor of the SKA.

Nissan director Johan Kleynhans accepted an award in the Automotive division for the Leaf electric car. The citation reads: "This award acknowledges the compelling mix of innovation, technological prowess and marketing excellence that has elevated the Nissan Leaf electric car to a level where it has become a viable choice in the fiercely competitive automotive arena. Its imminent introduction to South Africa (it's due in 2013) represents a significant milestone in planet-friendly motoring."

The Consumer Technology award went to Samsung South Africa, acknowledging what the judges termed "the formidable impact" of the company's innovative and technologically impressive Smart TV series, with its associated Smart Hub gateway to TV-optimised content.

Popular Mechanics editor Alan Duggan said he was extremely impressed by the range and quality of the inventions, commenting: "I was especially happy about the top award going to George Vicatos. His work is already changing lives for the better – and he has by no means exhausted his inventiveness." **PM**



In association with





Google Cloud Print makes your printer available to nearly any gadget, from nearly any location.

Cloud printing

Q My printer predates my computers, phone and especially my tablet, but it still prints just fine. How can I get this old thing to play nice with my fleet of wireless gadgets?

A The good news is that you aren't missing much. In an industry defined by reinvention and obsolescence, printing technology has stood relatively still. Printers are usually replaced when they break, not because something better has come along – a rarity in the electronics world.

Characteristically, printers have been slow to adapt to the rise of wireless gadgets. The newest Wi-Fi printers come with tools for connecting with mobile devices, but these don't work with other brands of printers. For those of us with a slightly older vintage of inkjet, there's Google Cloud Print.

Cloud Print lets you add any working printer to your Google account, where it can be accessed over the Internet without the need for special drivers or complicated software. It enables printing from Android and iOS devices, not to mention any PC or Mac, over a Web interface (and with apps). You can even share your printer with people in different locations or send items to your home printer while you're on the road –

although you'll have to leave your home computer on.

Here's how to set it up: on the computer that's connected to your printer, install the Google Chrome Web browser (google.com/chrome). Once Chrome is installed and running, click on the Settings menu in the upper-right-hand side of the window, represented by a spanner icon. Select Options (or Preferences on a Mac), which will take you to a settings dashboard. In the Under the Hood section, select Sign In to Google Cloud Print, enter your Google account username and password (if you don't have one, you'll need to sign up) and any printer connected to your machine will be instantly added to your Google account.

There are a handful of ways to send documents through Cloud Print. Your printer will now show up in both the

desktop and mobile versions of Google Docs, from which you can print documents you have created on or uploaded to Google's site. Documents stored on Android devices can be printed using a free Cloud Print app and from iOS devices using PrintCentral Pro. In addition, from your Cloud Print dashboard (google.com/cloudprint), you can share your printer via e-mail. Relatives, for example, are then able to send photos directly to your printer, whether they live across town or across the country.

AN INTERNET BUTLER

Q I'm so inundated with e-mails, messages and notifications that I'm starting to miss stuff. Is there any way to set special alarms – like a text message or a call – for, say, important e-mails?

A I'm always hesitant to recommend solving a noise problem with yet another layer of noise, but there is a way to do this. A new site called If This Then That (ifttt.com) lets you set triggers for specific events online, and then assign personalised actions to follow them. In your case, you could set a trigger for e-mails from an important e-mail address – let's say a parent's. You would then be asked to set an action to signal a new e-mail. In your case this would be a text message to your phone.

Yours is a simple case, but IFTTT is capable of much more complex notifications, with connections to dozens of major websites. It plugs into Facebook, Twitter, Craigslist, LinkedIn and plenty of other social networks, as well as a bevy of sites such as Flickr, YouTube, Google and Dropbox. It can also monitor stock prices and weather. You can set IFTTT to scour Craigslist for a desired item so that you get an e-mail when it's listed. You can get a call every time rain is forecast for the next day. You can have Facebook photos tagged with your name automatically backed up to a site such as Dropbox or Flickr. You can set text reminders for important dates or even get a daily wake-up call.

IFTTT users have posted hundreds of combinations, or "recipes", to help you get started building your own.

DON'T CONVERT THAT VIDEO

Q I've got hundreds of videos stored on my computer, but only a small portion play on my phone and iPod. Do I really have to convert them all?

MOTIVATION

THE GAME OF LIFE

It's a trick businesses have used for years: if you want people to stick with something, make it feel like a game. That's the thinking behind points-driven rewards programmes, loyalty schemes and referral systems. A new breed of apps and Web sites lets you use this trick on yourself, turning mundane – but necessary – tasks into games.

FITOCRACY	MINT	RIBBON HERO	GREENOPOLIS
THE TASK Exercise	THE TASK Personal finance	THE TASK Microsoft Office	THE TASK Recycling
THE MOTIVATION Points, badges, direct competition, peer pressure	THE MOTIVATION Financial-fitness scores, a goal-tracking system	THE MOTIVATION Skill levels, instructive task challenges	THE MOTIVATION Points, redeemable for vouchers and coupons
DOES IT WORK? Quantifying workouts in points is oddly addictive, even if they ultimately mean nothing.	DOES IT WORK? Imagine progress bars for major financial goals. They're counterproductive if they're not moving.	DOES IT WORK? An instructional manual disguised as a game. Great for learning Office; distracting if you have work to do.	DOES IT WORK? Well, how frugal are you? It promises plenty of twofer dinners and cheap movie tickets (in the USA).

A For all their talents, smartphones are pretty bad at playing video. They natively support an extremely narrow range of video types, and unlike computers, phones don't allow users to install the system-level software needed to decode other video formats. If your video isn't encoded in H.264 format, chances are you won't be able to play it on your device's default video player. So you'll need to get another one.

For Android users, the free MoboPlayer app is a must-download. This app will play any video your computer can. And file transfer is easy – just connect your Android device to your computer and drag and drop the video you want to watch.

The situation is less hospitable for iOS users. Of the various video apps for the iPhone, iPod Touch and iPad, the most versatile option is an app called Azul, which costs about R16. Like MoboPlayer, Azul will play nearly any video you can throw at it, but unlike with MoboPlayer,

adding videos to your device with Azul requires a bit of work on your part. Since iTunes permits only the syncing of compatible video formats, Azul requires videos to be added via the File Sharing menu in iTunes, under the Apps tab.

There are some downsides to using third-party video players. Android and iOS tap into special decoding hardware found in phones, tablets and media players to play H.264 videos. Other video formats can't use this decoder chip, leaving playback to the device's main processor, which, whereas it's likely powerful enough to play most videos, might choke on high-quality HD files. And even if MoboPlayer or Azul is able to play a video without shuttering or pausing, doing so will be a serious strain on your device's processor and, by extension, your battery. I've lost a fifth of a battery charge to one half-hour TV episode, but that may well be a sacrifice worth making.

PM





We're throwing away energy...

SOLVING OUR ENERGY PROBLEMS ISN'T JUST ABOUT PRODUCING MORE POWER, OR USING LESS. IT'S ABOUT GETTING THE MOST OUT OF WHAT WE ALREADY HAVE.

BY ALEX HUTCHINSON ILLUSTRATIONS KONRAD KIRPLUK

ONCE YOU KNOW WHERE TO LOOK, IT'S EVERYWHERE – dissipating, leaking away, drifting up in a puff of smoke. “When I see exhaust pipes and chimneys, I see wasted thermal energy,” says Chris Nelson, president of Cyclone Power Technologies. Nelson, whose father, Richard, co-founded Cogenic Energy Systems, a pioneering combined-heat-and-power company in the US, back in 1980, grew up hearing about squandered energy – and how to recapture it – over the dinner table. Now Cyclone is preparing to unveil a universal Waste Heat Engine that can generate electricity from the exhaust pipe of virtually any small-scale industrial engine or furnace.

How we'll fuel our future is often framed as a misleadingly simple, two-sided debate: we either have to produce more energy or use less. But that picture ignores a basic thermodynamic truth: for the same reason you should never pay cash for a perpetual motion machine, you can never make use of 100 per cent of the energy you consume. Something is always lost in the conversion from fuel to work.

Although that may sound like bad news, it also introduces a third way to address future energy needs. Right now, our energy conversion is abysmal, nowhere near the theoretical limits of efficiency. But with smarter design and new technologies, we can get a lot closer to those limits.

Consider a simple action like walking down the street. The energy that fuels you originally comes from the Sun and is stored by photosynthesis in the form of chemical bonds. “It turns out that food has about 100 times as much energy per unit mass as lithium batteries,” says Max Donelan, head of the Locomotion Laboratory at Canada's Simon Fraser University. That means the average person can store as much energy as a 1-ton battery can. But the process of converting those chemical bonds into muscle contractions wastes much of the stored energy. The remainder is used to accelerate and decelerate

your limbs – and that deceleration can be scavenged to generate power much like the regenerative braking in hybrid cars: Donelan has developed a lightweight knee brace that generates 12 watts of power from the simple act of walking – enough to give a cellphone 30 minutes of talk time after just 1 minute – with no extra effort.

The curse of inefficient conversions plagues everything from microchips to massive factories and power plants. When you boot up your laptop, the micro-processor inside is spewing heat that has to be dissipated by a heat sink and fan; the power brick that you plug into the wall is leaking energy in the conversion from AC to DC; and about 7 per cent of the electricity generated at a distant power plant is wasted in transmission losses while traversing the grid before the juice ever reaches your home.

The most common form of waste energy by far is heat, but power can also be squandered in unproductive motion (as in walking) or even in the millions of tons of edible food tossed into landfills. A 2010 University of Texas study estimated that discarded food contains more than 2 000 terajoules of embodied energy each year.

No single solution can address all these different types of waste. Instead, we need to engineer creative approaches to fit each situation, as the University of New Hampshire learned after installing a gas-fired cogeneration plant in 2006. "The plant completely changed the way we think about managing energy on campus," says Paul Chamberlin, the university's assistant VP in charge of energy and campus development.

The obvious gain was capturing excess heat that the turbine gave off while producing electricity and using it to heat campus buildings, boosting the generator's overall efficiency from 35 per cent to a maximum of about 85 per cent. Better yet, the university realised that landfill gas from a nearby dump, which otherwise would have simply flared into the atmosphere, could provide valuable extra fuel.

Less obvious, though, was what to do with all that extra heat in the summer – "free steam", as Chamberlin puts it. The solution: the university's new business school currently under construction will have steam absorption chillers instead of electric air conditioners, and other campus buildings will follow suit.

The biggest obstacles facing the quest for efficient energy conversion aren't just technical. We have an awareness problem. When it comes to kerb appeal, a nearly invisible diode that converts AC to DC with virtually no loss can't compete with a shiny solar panel, even though the latter is less efficient. And, as a rallying cry, "Run your engine as close to the Carnot efficiency limit as possible without violating the second law of thermodynamics" will never replace "Drill, baby, drill!" So a philosophical shift is in order. Yes, we need to keep pursuing new energy resources, but we must also make the most of what we have now. "When it comes to solving our problems with fossil fuels and the environment, these technologies are really the low-hanging fruit," Nelson says. "They're available now; they just need to be pushed."

... and here's how to get it back

Throwing it away:

Vibrations

Whether in bridges, shoes or keyboards, large movements beget smaller ones – most of which go to waste.

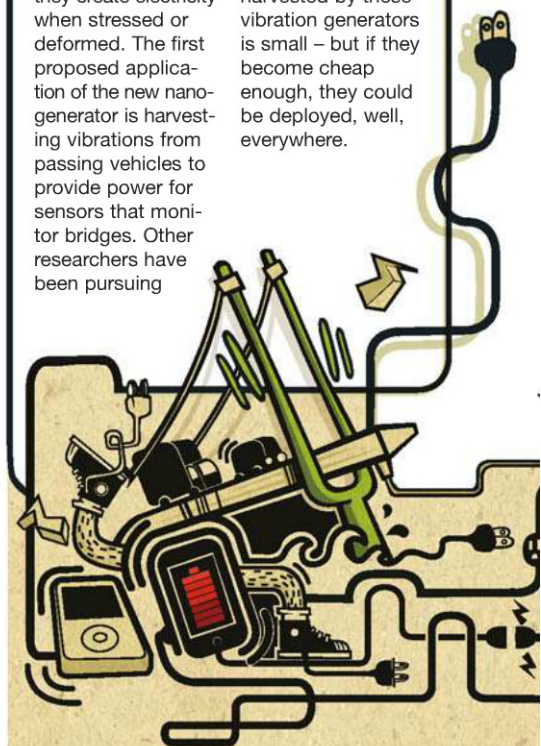
Getting it back:

PIEZOELECTRICS

+ 3 MICROWATTS PER DEVICE

In November 2010, Georgia Tech researchers built the first nanogenerator capable of powering portable electronics. A simple squeeze of the fingers generated 3 microwatts, enough to light up a liquid crystal display. The generator contains zinc-oxide nanowires, which are piezoelectric, meaning that they create electricity when stressed or deformed. The first proposed application of the new nanogenerator is harvesting vibrations from passing vehicles to provide power for sensors that monitor bridges. Other researchers have been pursuing

similar goals. Princeton University scientists have developed "piezo-rubber" that they hope will power implantable pacemakers, eliminating the need to replace batteries. Engineers at Louisiana Tech University have even built a piezoelectric generator into the heel of a shoe. The amount of power harvested by these vibration generators is small – but if they become cheap enough, they could be deployed, well, everywhere.



Computer processing

The same inefficiencies that warm our laptops are a serious problem for data centres and supercomputers.

PYROELECTRICS

+ 8 WATTS PER CHIP

Modern computer chips face two related problems: they consume too much power and turn too much of it into heat. In fact, businesses around the world already spend R250 billion a year powering their data centres. Turning excess heat into electricity attacks both problems at once; that's what a new pyroelectric device developed at the US Department of Energy's Oak Ridge National Laboratory aims to do. Not to be confused with better-known thermoelectric materials, pyroelectric materials generate a small voltage from changes in temperature. The device relies on a tiny cantilever that oscillates between the hot computer chip and a pyroelectric heat-sink, removing heat and generating electricity with each cycle.

A single cantilever produces only 1 to 10 milliwatts of power, but you can fit 150 of them in a square centimetre – ideal for large data centres and petaflop-scale supercomputers, according to Oak Ridge scientist Scott Hunter.

Walking

Of the kilojoules used to propel a person down the street, fewer than half are dedicated to forward motion.

BIOMECH GENERATORS

+ 20 WATTS PER PERSON

Walking down the street is a terrible waste of energy – so imagine how much power a platoon of marching soldiers squanders. The military will be the first market for biomechanical generators such as Bionic Power's PowerWalk M-Series, a 750-gram knee brace that spins built-in gears to run a tiny generator with each stride. A typical human's stride generates 12 watts of energy – and since the brace harvests energy only from the braking portion of the stride, when effort is actually being expended to

slow the leg, tests have shown that it requires no additional energy from the user.

Along similar lines, a spring-mounted backpack developed at the University of Pennsylvania collects more than 20 watts from the up-and-down motion of the pack, a figure that varies depending on the weight of the load.

(A heavier load results in greater power generation.) For comparison, 3 watts is enough to charge a low-power cellphone in just over an hour, or to continuously power a survival beacon or flashlight.

Power conversion

The fundamental design of our energy grid requires frequent – and loss-prone – AC-to-DC power conversion.

GALLIUM-NITRIDE DIODES

+ 100 WATTS PER PERSON

Every time you plug your cellphone, laptop, HDTV or other electronic device into the wall, you're converting AC power from the grid into electronics-friendly DC power. The reverse happens when DC power from solar panels or wind turbines is converted to AC to feed into the grid. "Power conversion is happening everywhere, in every appliance that uses energy," says Umesh Mishra, CEO and co-founder of Transphorm, a Google-backed startup. "These conversions are very lossy: 10 to 12 per cent of electrical energy generated in the US is lost to conversion." The solution, according to Mishra, is to make the diodes and electrodes that help perform this conversion out of a semiconducting material called gallium nitride rather than silicon. Since the atomic structure GaN is capable of holding three to five times the voltage of silicon without leaking, it can reduce waste by 90 per cent at each conversion step. Transphorm's converters are already slated for use in large-scale data centres but could ultimately be incorporated into virtually any electric product, Mishra says.



Throwing it away:

Driving

Endemic friction saps energy from the fuel we use to power cars and trucks before it ever reaches the wheels.

Getting it back:

THERMOELECTRICS

+ 350 WATTS PER CAR

Only about 20 per cent of the energy contained in your fuel tank actually goes to propelling your car forward. The rest is lost as heat through the engine, the drivetrain components and the exhaust. GM, Ford and BMW are all testing prototype thermoelectric systems that generate electricity from the heat gradient between the exhaust and coolant systems, with the goal of improving fuel economy by as much as 5 per cent. The biggest challenge to harnessing this wasted energy is finding a

thermoelectric material with high enough efficiency that can also stand up to the rigours of the road for a decade or more. It's a hostile environment under the bonnet, acknowledges Dan Coker, president and CEO of Amerigon, the company behind BMW's and Ford's hafnium-zirconium prototypes. In the short term, the most promising avenue for thermoelectrics may be heating and cooling in cars with electric or hybrid drives, Coker says. In fact, Amerigon's thermoelectric seats are already available in 55 car models.

Motor operation

A flaw in the design of many electric motors keeps them running at full power, whether they need to or not.

VARIABLE-SPEED DRIVE

+ 100 KILOWATTS PER MOTOR

There are about 300 million industrial electric motors installed around the world. Almost all of them run constantly at full speed and use some form of mechanical damper to regulate output – the equivalent of driving with the accelerator pedal to the floor while using the brake to control your speed. But it's now possible to use computer-controlled variable-speed drives that match the power output to demand in real time, by adjusting the input voltage and frequency like a light-dimmer switch, says Mark Kenyon of motor manufacturer ABB. Dropping the flow rate of a pump or fan by 20 per cent when full capacity isn't needed can reduce power consumption by up to half. Installing variable-speed drives in all the industrial electric motors around the world would save the equivalent power output of 286 nuclear reactors, according to ABB, and the savings would pay for the required capital investment in one to three years. Hearst Tower, which houses the PM offices and was completed in 2006, utilises variable-speed motors in its elevators and chiller-plant cooling system.

Exhaust heat

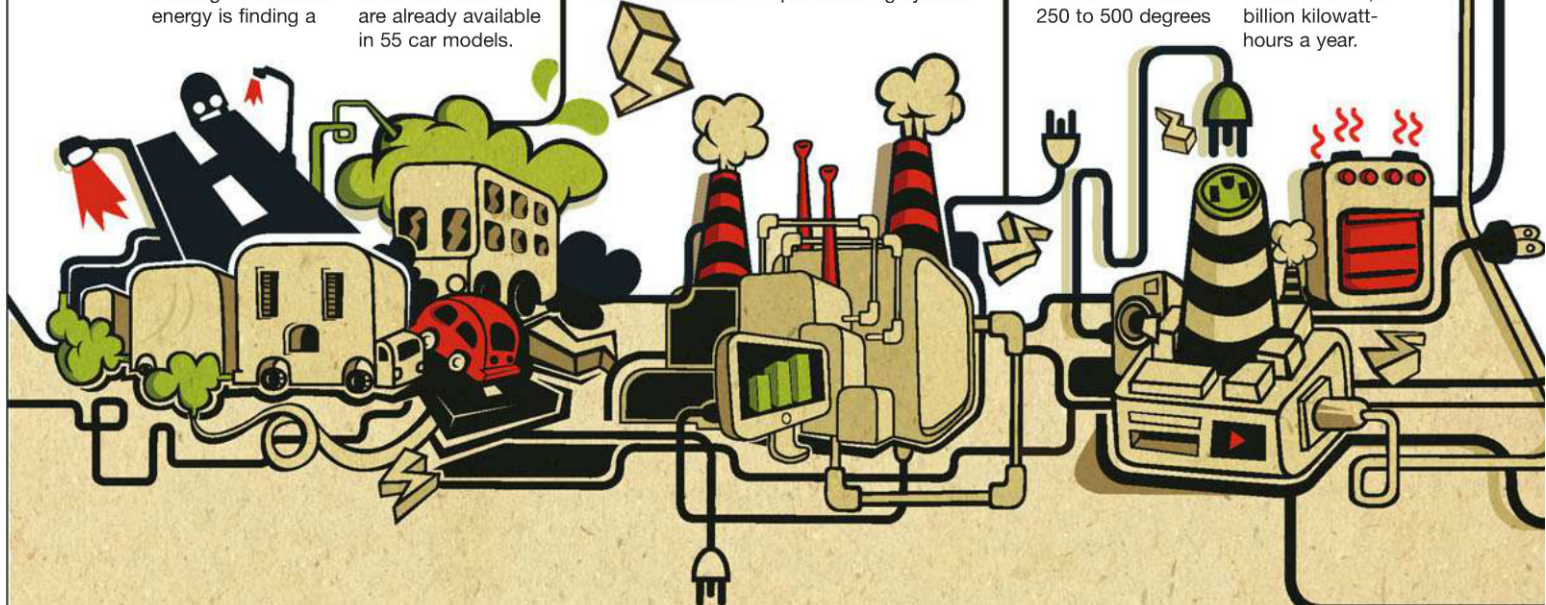
In aggregate, medium-scale industrial equipment produces enormous amounts of difficult-to-collect heat.

WASTE HEAT ENGINE

+ 250 KILOWATTS PER ENGINE

Recapturing waste heat from an enormous power plant is a no-brainer, thanks to the superhigh temperatures and economies of scale. But much more common are small industrial facilities with furnaces, ovens, incinerators and engines, where the amount of waste heat is too small to efficiently power a full-fledged turbine. Cyclone Power has developed a versatile Waste Heat Engine that can tap into the exhaust of pretty much any industrial process, using more modest heat from 250 to 500 degrees

to power reciprocating radial pistons in a Rankine cycle generator. "Our target is much smaller scale distributed power, from about 5 to 500 kilowatts," says Cyclone president Chris Nelson. One of the first uses is actually mobile: running refrigeration and auxiliary power in long-haul trucks, saving 5 to 10 per cent on fuel. The company estimates that there are also 10 000 industrial installations in the US that would be suitable for the Waste Heat Engine, which could save 13.5 billion kilowatt-hours a year.





Waste decomposition

Decomposing matter releases “trash air”, which is both energy-rich and highly polluting, into the atmosphere.

LANDFILL GAS-TO-ENERGY

+ 7,9 MEGAWATTS PER LANDFILL

Food is a highly efficient energy-storage mechanism: a 50-gram granola bar contains as much energy as a 5-kilogram lithium battery. Rotting organic matter in landfills releases some of that energy as gas, typically about 50 per cent methane, which can be captured, cleaned and burned to generate electricity and heat. Before its 7,9-megawatt EcoLine cogeneration project could start operating, the University of New Hampshire had to build its own gas processing plant to enrich the gas from a nearby landfill. This facility is necessary to remove carbon dioxide, as well as strip out contaminants such as sulphur and volatile organic compounds.

Landfill gas-to-energy projects are about to take off in South Africa, as part of the government's Integrated Resource Plan 2010 (see our feature on converting landfill gas into electricity, “Burn it up”, November 2011). The plan sets a benchmark of 3 725 MW to be generated from renewable sources by 2013, and 7 200 MW by 2030. Sites being developed around Johannesburg each have the potential to produce about 20 MW for around 15 years, enough to electrify about 15 000 homes.

Grid management

Fluctuating demand and steady generation leave electricity with nowhere to go at night.

GRID STORAGE

+ 20 MEGAWATTS PER STORAGE PLANT

If the wind spins a turbine in the middle of the night, does anyone use the power generated? Not really. Due to steady supply and a drop-off in demand, off-peak power is often much cheaper than peak power, so we need the ability to “time-shift” power by storing it temporarily. It's not just about night and day: about 1 per cent of total generation capacity is wasted on balancing out the minute-by-minute fluctuations of supply and demand – waste that can be eliminated by grid-scale storage.

In June, a US fly-wheel storage plant in Stephentown, New York, reached its full 20-megawatt capacity for the first time, using 200 magnetically levitated fly-wheels spinning at 16 000 r/min. Spain's Gemasolar concentrated solar array is able to generate power around the clock by storing energy in molten salt tanks. Other promising technologies include giant chemical batteries, compressed-air tanks and water-elevation pumps.

Power transmission

Outmoded, inefficient copper wiring is both our power infrastructure's backbone and a major source of waste.

SUPERCONDUCTING CABLE

+ 50 MEGAWATTS PER POWER PLANT

Transmission losses squander about 7 per cent of the electricity we generate. Superconducting wire can conduct 100 times the current across supercooled lines than comparable copper cables – with virtually no losses. The problem is that risk-averse electricity supply utilities are hesitant to embark on massively expensive transmission-line projects with a radically new and unfamiliar technology, according to Jack McCall, American Superconductor's head of transmission and distribution technologies. American Superconductor installed a short demonstration line on Long Island in 2008, but McCall hopes the use of superconductors to link the USA's three leading power grids at the proposed Tres Amigas SuperStation in New Mexico (set to open in 2014) will kick-start greater acceptance of the technology. Meanwhile, South Korea and China are forging ahead with superconducting transmission projects, which should help make the price more competitive with copper.

PM

JETPACK AT LAST

> BY JEFF WISE

> PHOTOGRAPHS BY FILIP KWIATKOWSKI



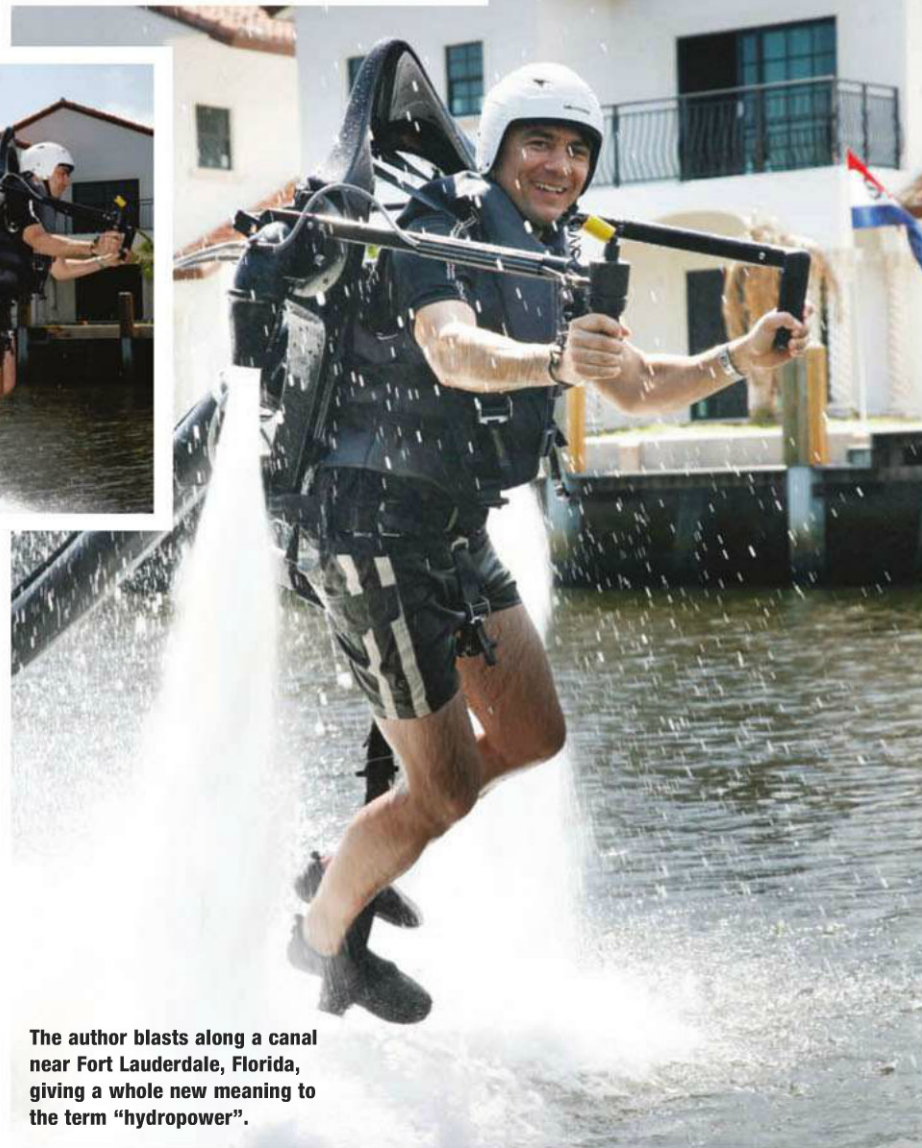
AFTER A HALF-CENTURY OF YEARNING, PM CAN FINALLY PILOT A JETPACK. SCIENCE FICTION, MEET SCIENCE FACT.

Early on a quiet Sunday, only a few people are on hand to gawk as my instructor gives me a helmet and a lifejacket and straps me into the sleek aluminium-and-composite frame of a jetpack. Gingerly, I make my way down a slippery boat ramp and wade out into the cool, murky water of a South Florida canal. As the bottom slopes away, I start a leisurely dog paddle. Any alligators around here, I wonder.

"Okay, engine on," says a voice in my radio earphone. "Throttle up."

I twist my right hand, and with a low rumble, the jetpack begins to move me forward through the water. I twist more and my chest rises above the surface, then my hips. The twin nozzles clear the water with a whooshing sound like a fire hydrant turned on full blast. I continue to accelerate as my knees emerge, and then my feet. I'm completely out of the water, floating. I shift my weight to the right and ease into a gentle turn. I'm flying!

It's true: the jetpack has finally arrived.



The author blasts along a canal near Fort Lauderdale, Florida, giving a whole new meaning to the term "hydropower".

Granted, it's not the kind of rocket-powered contraption we expected to be flying by the 21st century. Instead of hot gases, this device – the Jetlev R200 – soars on thunderous towers of water that shoot down from twin nozzles. It's a bit like riding around on a pair of fire hoses. To provide that water, the nozzles are connected via a 10-metre hose to a floating pod containing a 190-kW engine that powers a pump. Wherever you go, your supply of high-pressure water

trails behind. It's pretty noisy; the volume is comparable with a motorboat at full throttle, but it's a very different sound – more like a good-size waterfall.

Balancing atop a pair of man-made geysers sounds tricky, but the controls turn out to be quite simple. Two handlebars project forward from the frame at shoulder height. They connect to the outlet nozzles so that moving the handgrips up and down angles the thrust downward and backward.



VIDEO

> Watch Jeff Wise put the Jetlev R200 to the test on www.popularmechanics.co.za

Move one handle up and the other down, and you turn. The right-hand grip also rotates like a motorcycle accelerator to control the overall thrust. The user's balance and low centre of gravity provided by the weight of the water in the inlet hose keep the Jetlev upright.

Once I get the hang of balancing myself, I circle left and right, then carve a few figure eights. Keeping the Jetlev under control takes concentration. Pulling the handles down increases your forward speed but reduces lift, so to compensate you have to throttle up at the same time or else you'll lose altitude. Still, after about 5 minutes I'm comfortable enough with the controls that I can trace a wobbly path up and down the canal, rising and sinking as I go.

In the hands of a capable operator, the Jetlev can wander hither and yon, pulling its floating pump behind it at speeds up to 35 km/h. The hydrogen-peroxide-powered Bell Rocket Belt, a device that was developed for the military and worn by James Bond in *Thunderball*, stayed aloft for only about 20 seconds. The Jetlev can fly for hours at a time. You're more likely to run out of fuel before it does.

Within 15 minutes, in fact, my arms are painfully tired. Beginners, apparently, grip the controls too tightly. I throttle down, settle into the water near the ramp and take a breather. While I rest, Jetlev chief pilot and instructor Steven J Grey takes the machine and begins manoeuvres, leaping skyward straight from the dock, plunging below the surface, then skimming

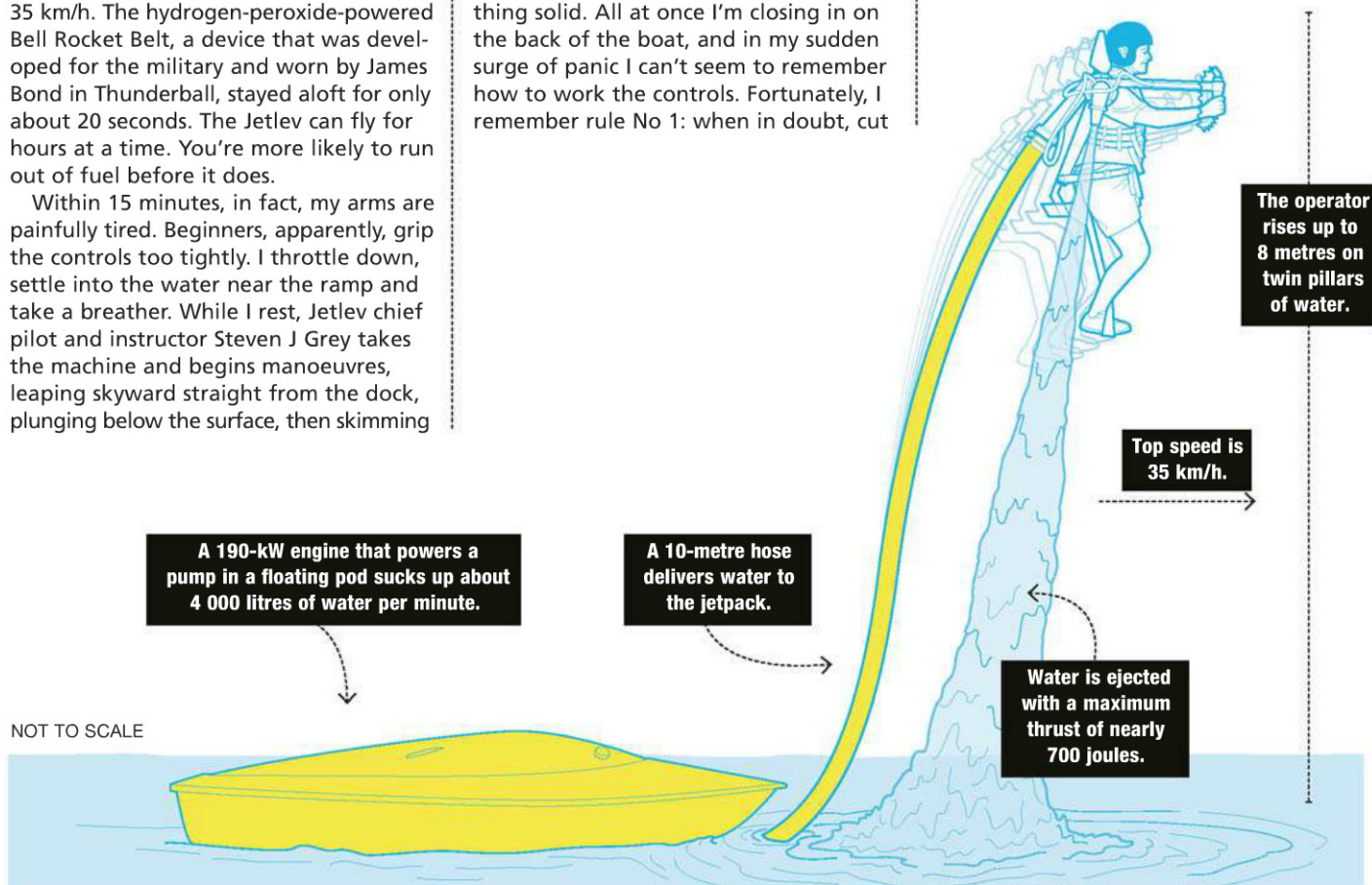
over it like a torpedo before zooming vertically like a launching missile. Cool? Very.

As soon as I can lift my arms again, I strap back in. Grey hops into a motorboat, and I follow him down the canal, disrupting the flow of weekend traffic as boaters stop and stare. Now that I'm feeling a little less shaky, Grey urges me to climb higher. Even at only 3 metres up, I get a feeling of vertigo, like I'm balancing on top of a wobbly ladder: It just doesn't seem possible that I'm floating up here. Still, there's no danger in pushing the limits, since the worst that can happen is that I get a good dunking. So I slalom behind Grey's boat, feeling the rhythm, leaning into my turns and co-ordinating the angle of the handlebars with the necessary changes in thrust.

Then I make a turn a little too fast and a little too high and realise that I actually could hurt myself: I could fly into something solid. All at once I'm closing in on the back of the boat, and in my sudden surge of panic I can't seem to remember how to work the controls. Fortunately, I remember rule No 1: when in doubt, cut

the power. I crank the throttle back and cannonball into the canal. Stroking upward through the murky brine, I've never been so happy to have water shoot up my nose.

A twist of the handle, and I'm back in the sunshine, dripping and smiling from ear to ear. I've experimented with lots of cockamamie contraptions, and most of them have come up short. The Jetlev is different. Not only is it a remarkably successful piece of engineering, but the experience it offers is the most exhilarating thing I've tried since surfing. Sure, the R800 000 price tag may be a tad steep for the average weekend warrior. But I think beachside rental shops will have little trouble finding customers. It turns out that after waiting all these years for our jetpacks, they really are as fun as we imagined. **PM**



DIY HOME

> BY ROY BERENDSOHN



SEEING the LIGHT



A glow-in-the-dark flashlight mount is easy to make and can be a godsend during a blackout.

so one suffices for a wall attachment, but you might want to use two if, for instance, you're hitching a torch to the interior of your car, truck or boat.

In lieu of the all-purpose screws packaged with the brackets, I used No 8 20 mm round-head wood screws. I affixed the mounting block to the wall with two self-tapping 60 mm wood screws.

The rig might appear to be overkill, but it's merely built to last. Unless you fasten the bracket firmly to the block and the block tightly to the wall, you'll loosen the holder the first time you remove the torch.

I bevelled the edge of the wood block, painted it the same colour as the wall and applied a stripe of glow-in-the-dark paint on the ends. Two coats of the phosphorescent acrylic create a good beacon, but if I ever install another setup elsewhere in the house, I'd go with three coats for even greater brightness – and ease of finding my way in the dark.

UNIVERSAL DRILL

Q Is there one drill bit that works with multiple materials, including wood, metal and concrete? I want to carry a single type of bit, if possible.

A There are at least two drill bits on the market that claim to be effective with all materials. Bosch calls its version "multi-construction" and Artu – which says its bits will even bore through glass – uses the label "multipurpose". Both manufacturers say the products can be

Q I keep torches stored all over the house because we lose power often in our neighbourhood, and at least half of the outages occur at night. What's the best way to store a torch so I can find it in the dark?

A Yep, a torch will do you absolutely no good unless you can find it in the dark. The photo above shows the simple setup I use at home. The holder consists of nothing more than a 30 cm piece of 25 x 100 pine with a Maglite D-cell torch mounting bracket screwed to it. The brackets are sold by the pair; they have a sure grip,

used in rotary or percussion mode, though you obviously wouldn't want to put a hammer drill to glass!

I lug around a lot of tools, so I understand why you'd want to simplify your kit with a universal bit. In fact, I get a lot of use out of my multipurpose tools and accessories. But I do employ dedicated bits and blades depending upon whether a job demands precision, speed or cleanliness. When drilling large holes in timber, for instance, I reach for a razor-sharp auger bit.

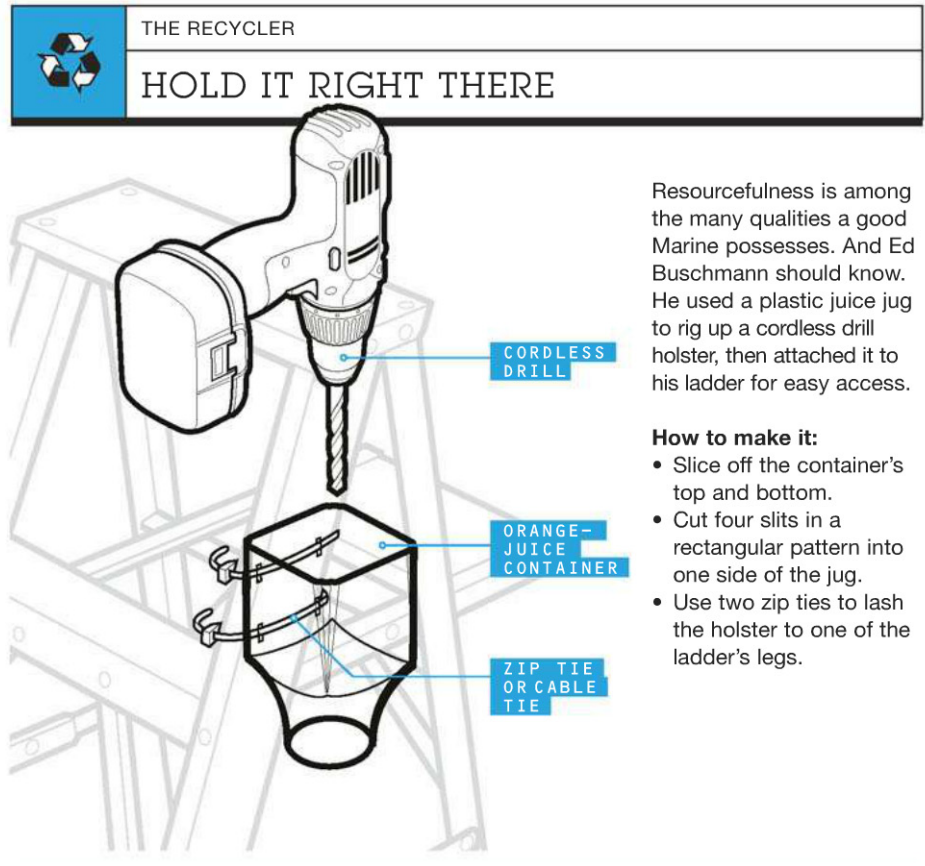
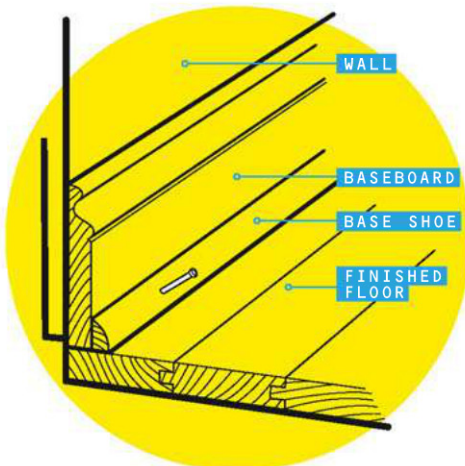
Regardless, I still believe in general-purpose bits. A set of M2 high-speed steel bits can be an asset to anyone who's handy with a drill. With a tip geometry of 118 degrees, they'll readily bore through wood and even steel. Incidentally, when drilling steel, use cutting fluid; if you're using the tool at an angle or drilling upward, use a gel or cream lubricant to make sure that it stays put as you make your hole.

TRIMMING THE CONFUSION

Q I'm going to install some new 150 mm skirting board, door and window trim. Which is better to trim the bottom of the skirting board – quarter-round or base shoe moulding? I really don't see much difference between the two.

A I prefer base shoe moulding, in part because it has a more elegant look than quarter-round. Also, as its name implies, the quarter-round is shaped like a quarter of a circle (well, technically, a cylinder), so it can be tough to drive a nail through it and into the baseboard. Base shoe moulding, on the other hand, has a broad vertical surface that is easier to nail.

I understand why some people prefer



THE RECYCLER

HOLD IT RIGHT THERE

Resourcefulness is among the many qualities a good Marine possesses. And Ed Buschmann should know. He used a plastic juice jug to rig up a cordless drill holster, then attached it to his ladder for easy access.

How to make it:

- Slice off the container's top and bottom.
- Cut four slits in a rectangular pattern into one side of the jug.
- Use two zip ties to lash the holster to one of the ladder's legs.

quarter-round. It's as flexible as rope, a useful quality when working with a wavy floor, for instance. But the lack of a flat nailing surface can be a major drawback: unless you're using a pneumatic finish nailer, the moulding can easily split or, at least, suffer hammer dents. Assuming I've made a good case for shoe moulding, install it by nailing it not to the floor but to the baseboard. This allows the floor to expand and contract freely, with no negative impact on the moulding.

Since I don't know the size of the moulding you're installing, it's tough for me to recommend a nail size, but my guess is that 4d will do the trick.

LOST AND FOUND

Q We recently moved and I brought some blinds from the previous house to install in our new place, but I lost the mounting hardware in the move. The blinds were quite expensive and my local hardware store doesn't stock what I need for the job. Is it worth it to try to make my own mounting brackets, or should I just buy new blinds?

A The first thing I'd do is look around on the Web for local suppliers or

contact the retailer that sold you the blinds. Some online retailers sell hardware separately, and if you bought the blinds in a bricks-and-mortar store, it can't hurt to ask. Some general sources carry an extensive selection of hardware for drapery and blinds. If you have to fabricate the parts, I suggest modifying an existing bracket or other piece of hardware. Just drill, saw and grind it to fit your needs. Over the years I've done this with joist brackets and metal angles, and it's not as difficult as you might think. One word of advice, though: carefully clamp the piece you're working on to ensure that the drill bit, saw blade or grinding wheel doesn't send it flying.

LIGHTNING STRIKES TWICE

Q We get a lot of thunderstorms where we live, and when lightning strikes nearby, our six smoke detectors go off. The house was built in 2007, and the two electricians I've spoken to can't solve the problem. Please help!

A You've probably heard the expression that electricity follows the path of least resistance. That's what's happening



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here. The grounding system outside your house isn't working properly; instead, it's conducting the currents caused by the lightning into your house, which is precisely the opposite of what should be happening. The energy surge sets off your smoke detectors, which are basically current-reading devices. "Some fire and security alarm systems are triggered by what they perceive as a test input," according to electrical engineer Joe Cristino, who specialises in power systems. "The problem can be difficult to eliminate, but you should be able to minimise it to an occasional sounding."

Before I explain how your problem can be fixed, I'd like to provide some background. A lightning bolt strikes with an electromotive force of up to 300 million volts. The currents it creates can move through the earth, the electrical grid, household electrical systems and metal structures. Computers, televisions and appliances and portions of a home's electrical system can be roasted by the massive surge. Those currents aren't supposed to get into your house; they're supposed to dissipate into the earth through large metal stakes, known as ground rods, connected to the house's grounding system. Fixing the problem requires calling in a professional who specialises in installing lightning-protection systems. The pro will test the conductivity of the soil around the house, then design and install a low-resistance grounding system. The electrician may also put in a transient-voltage surge suppressor on the main disconnect at your home's service panel. This device diverts and absorbs excess currents, otherwise known as a surge or transient surge.

Finally, the electrician will check the house's "bonding" – the screws, bolts, clamps, bushings and short lengths of wire linking the home's metal components that do not normally carry current. These parts should be configured to form an electrical path that grounds stray currents, rather than letting them course through your home's wiring, plumbing, sheet-metal ducts or heating and cooling equipment.

ROLL WITH IT

Q Sometimes when I use a paint roller on a smooth surface – when I was recently painting some doors, for example – it slides like a squeegee. What can I do to prevent this?

A Many products perform at their best right out of the box. But a select few, including paint-roller covers, get better over time. "A high-quality paint-roller cover will improve with use," confirms Bruce Schneider, a painting trainer and marketing manager for a manufacturer of roller covers and brushes.

"Using and cleaning the cover improves its yarn and makes it more absorbent. This helps the cover to hold and release the paint properly, so that the coating can be rolled onto the surface rather than pushed along it."

So do what the pros do: precondition a roller before you get down to business. If you're using latex paint, saturate the roller with water and spin out the excess. If you're using an alkyd or other chemical-solvent paint, use paint thinner or other prescribed solvent to prep the roller. Pre-treatment washes out loose fibres left in the roller from the manufacturing process. These yarns can mar the finish the first time you use a roller cover.

Another tip: don't overload the roller with paint. The excess runs off the cover and forms a puddle that makes the roller more likely to slide than to turn properly around its axle. To get the right amount of paint on the roller, dip it in paint and roll it back and forth on the tray ridges before application. Finally, don't use a too-thick nap on slick surfaces.

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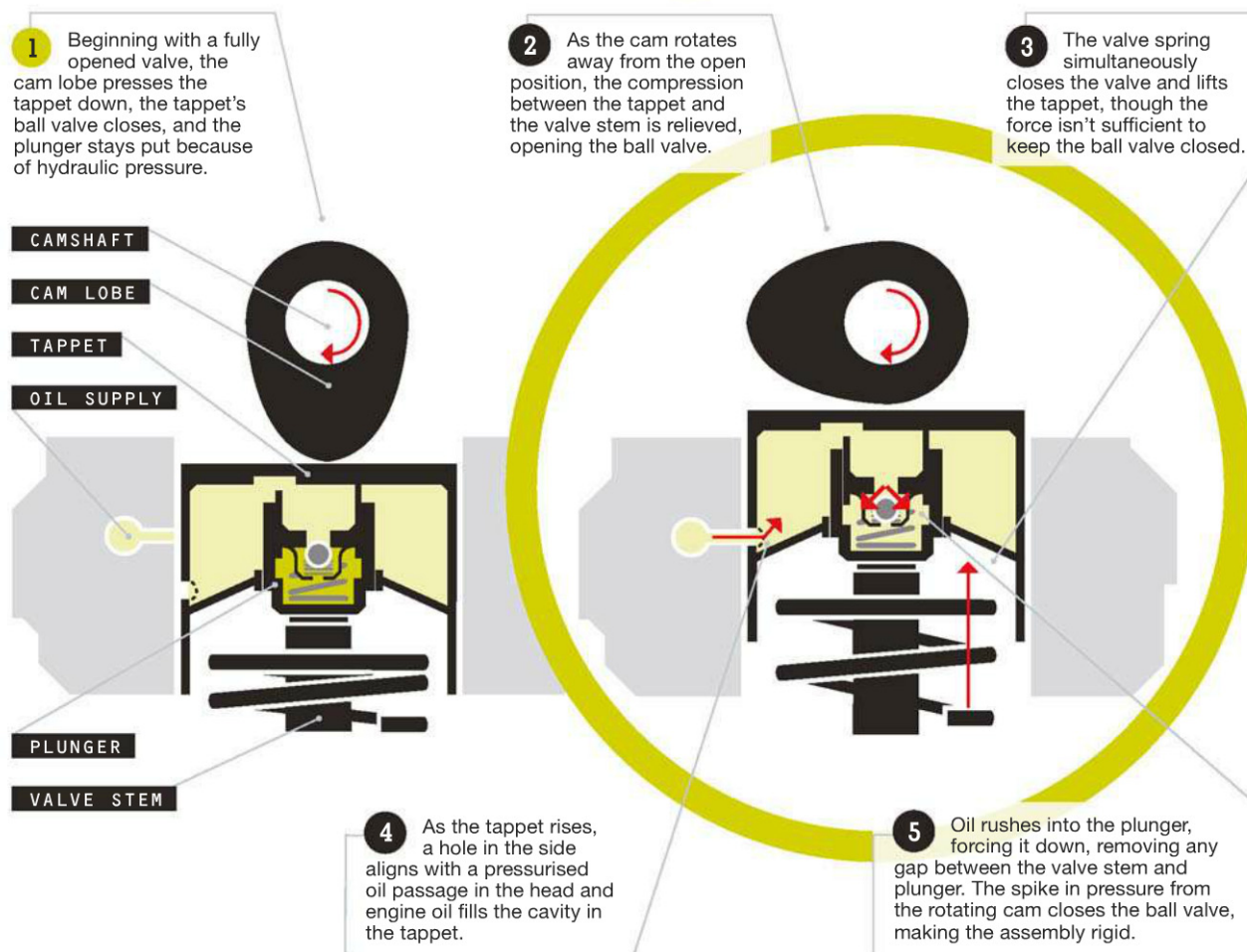
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Touch tomorrow

CAR CLINIC Q+A

> BY BEN WOJDYLA



The tale of the ticking tappets

Q I have a 1986 Saab 900. The car had been sitting for a while, and when I started it there was a pronounced ticking noise from the engine. A friend said it might be a tappet and I should run the engine to see if the problem would go away. Unfortunately, after running the engine for a bit the sound didn't go away. The guys from Saab enthusiast Web sites suggest adding Marvel Mystery Oil to the crankcase. Will that work? What is Marvel Mystery Oil, anyway?

A That ticking you hear is your Saab's hydraulic tappets. These devices were introduced in the '30s, but became wildly popular in the '80s as improved reliability became an important selling feature. They're an innovative way to solve an old problem: how to keep valves properly adjusted. Depending on the engine, either the end of a rocker arm or the camshaft lobe pushes the valve open. The degree of the valve opening is a precise measure-

ment, and over time the parts wear, so the valve opens less than is optimum. That's why valves used to need periodic adjustment – a fiddly job that required removing the valve cover, measuring the clearance, and either turning a setscrew or installing shims. Now we have self-adjusting hydraulic tappets placed on top of the valve stems.

These little devices consist of a piston inside a cylinder, which is fed oil pressurised

by the engine's oil pump. The oil fills a low-pressure chamber in the top of the tappet. A ball valve between the low- and high-pressure chambers opens if there's any gap between the bottom of the tappet and the valve stem, and oil flows in, adjusting the length of the tappet to the proper setting. Since oil's volume doesn't change when it's compressed, the tappet acts like a solid link between the camshaft and valve.

The first suggestion to just let the car run was a good one. Often when a car sits, the oil in the tappets bleeds off, and it may take some time – a few seconds up to a minute or so – for them to "pump up" to adjust. In the meantime, that ticking noise results from slop in the system.

Since running your car didn't silence the ticking, in all likelihood those tiny moving parts and oil passages have become gum-

med up. Something in those lifters may be stuck. The solution? If you haven't done it already, change the oil. Then drive the car. A fresh batch of hot oil may clean out all the gunk.

If that doesn't work, head down to your local auto parts store and ask for the latest and greatest antivarnishing agent. The list includes Marvel Mystery Oil (I couldn't locate a South African distributor): when added to engine oil, MMO's characteristics include the ability to clean varnishes away, as it can act as a solvent.

Hydraulic tappets rarely fail completely, but on the off-chance the problem doesn't go away after these remedies, you may have to go through the expensive and time-consuming process of buying a new set of tappets, pulling off the valve cover and any associated accessories and camshafts, then replacing the entire set of tappets. If one fails, they're all suspect.

As for what's in Marvel Mystery Oil? It was developed by Burt Pierce in 1923 to clean clogged carburettor jets. It's a light-oil base with a blend of lubricants and solvents. Beyond that, its exact composition remains, well, a mystery.

Splitting a headache

Q I've been trying to replace my rusty and well-ventilated old exhaust system with a new one, starting after the manifold. After many attempts to remove the nuts from the flange bolts, all I'm left with are rounded-off nuts and a garage full of profanity. Do you have any tips on how to remove these stubborn, rusted-on nuts?

A Normally, applying a combination of penetrating oil, leverage and heat is enough to either free a nut or break the bolt; unfortunately, in your case more drastic and destructive measures seem necessary, even prudent. Allow us to introduce the nut splitter. It's a simple and effective device designed to split a nut down the side so it falls away, never to be used again. As a tool of last resort it should be used sparingly, but in this instance it's the right choice. Place the splitter over the nut, with the chisel point on one of the nut's flat sides, and tighten it with your fingers. Get an appropriate wrench and continue tightening the mechanism until the nut splits. Remove the tool, then discard the extricated nut.

Flickering lights

Q The dash lights on my 2009 model Chev come on only dimly in the daytime even though I have the rheostat knob turned all the way up. This makes it difficult to read the speedometer and



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Form-A-Funnel drain tool
We still change our own oil because, well, it's cheaper than therapy. And this formable funnel makes the process even more enjoyable because it catches the fluid that inevitably spills from the filter and coats the car's underside.

All items available via wantitall.co.za

other dials. The dash lights come on at full brightness when it's dark. Sometimes after I drive for about 30 minutes I'll hear a click under the dash and the lighting will come on. My dealer replaced the light sensor atop the dash, but that didn't remedy the problem. I'd like to get this resolved while the car is still under warranty. May I have your thoughts, please?

A This is a strange one, especially on such a new car. Usually when gauge clusters dim it's because they're old and the phosphors in the LCDs have worn out – they're sensitive to the heat buildup from the dashboard electronics and heating systems.

Your problem sounds more like an electronic controls issue. The clicking sound you mentioned hearing under the dash leads me to believe it's not the sensor, but rather a relay between the car's body control module and the instrument panel. The body control module takes signals from the instrument panel light control (your rheostat) and the light sensor and sends a signal to set a certain level of illumination.

Contrary to what you might think, nighttime lighting is actually dimmer than daytime lighting. Manufacturers step the illumination down because the contrast at night is so much higher. If you have a bad relay, you aren't seeing full power at night, you're just seeing normal nighttime power all the time. That's a guess, but worth asking your dealer about.

The other option (especially since the

car is under warranty) is to ask the dealer about replacing the gauge cluster. The subassembly is fairly expensive, but it's a relatively easy replacement. The problem could simply be a malfunction of the cluster's onboard electronics.

Scratching the surface

Q I've got some light scratches in my windscreen. My nail doesn't catch in them, so they're not deep. Can I buff these out? How?

A There are two ways to address light scratches in glass. The easiest is to fill the scratches with an acrylic scratch remover, which is applied as a liquid and dries hard and transparent, hiding the damage by filling the scratches chemically. For deeper scratches, the most popular fix is buffing the glass with cerium oxide, a popular glass, ceramic and metal polish with very low abrasiveness – it's widely used in jewellery and ceramics. Add water to the fine powder and make a thin slurry; then cover the damaged areas with the paste. Using a drill with a hard rubber polishing wheel attached, apply firm pressure to slowly grind the surface smooth. To make things a bit easier, mark the location of the scratch on the other side of the glass so you can keep track of where you should be working. It may take a while, but keep the paste moist and add more cerium oxide as needed, and the result will be a smooth, scratch-free surface.

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Smart is good – Wise is better!

January 2012 will go down as a landmark month for South Africa's growing technology sector with the launch of our first ever 'localised PC tablet device'

The first time the world saw a "tablet" was in January 2010.

And here we are, just 24 months later and South Africa is about to give birth to its very own "lean-back-and-enjoy" personal computing device. It's the brainchild of Wise Tablets, a locally based IT company that's been in the game for more than 20 years – and has recently developed what it describes as a "South African-made tablet, made for South Africans". In a nutshell, it is called the Wise Touch 1, it is available in 7-inch and 10-inch screen formats as well as a very popular 8-inch and 9-inch range, and it runs on the Android 2.3 platform. What makes the Wise Touch stand out from the crowd, however, is not what's inside the casing – it's what's pre-loaded on the device.

As you would expect, the Wise Touch gives users access to the global Android market with thousands of applications, but the pre-loaded, localised content comes to life via the Wise Shopping

Mall and Business Park, which features more than 10 category departments and 80-plus different applications offering direct access to a wide variety of local retailers, travel shops, banking, food courts, videos, TV, movies, toys, and more. As Wise Management explains, from the moment you take it out the box, you can "browse a selection of local retail stores with up-coming functionality that enables you to read a magazine or today's newspaper in the magazine store or order takeaway meals from your favourite restaurant in the food court – all from the comfort of your own home". In essence, it's an easy, interactive and (thanks to the tailor-made, localised content) unique shopping experience. But there's a second pre-loaded content world at the heart of the Wise Touch project – The Education Centre.

Focused on learning and education, the applications within the Education Centre offer a variety of educational content, including a public school syllabus. All of them will be bundled free with the Wise Touch – and numerous universities, private schools and colleges have jumped on board to ensure that the educational content offered continues to expand. Says Wise Management: "We aim to make the tablet a practical tool for education and so work directly with educational institutions to develop their own content and use it on the Education Centre, which provides a standard way of viewing educational content via a removable SD card. Interactive content is very impressive and supplied from Siyavula. This content sets a benchmark for using existing school text books and making them fully interactive with video content included." This is particularly relevant in a country where the cost of technology is often a hurdle to success. Wise Management goes on to explain: "Our intent with the Wise project was to focus on a completely different market segment. The 10-inch tablet will retail for less than R3 500, the 7-inch 3G tablet, which we expect will be the most popular, will retail for less than R2 500 – and the entry level 7-inch Wi-Fi device will cost less than R1 700."

All of which makes South Africa's very first home-grown tablet device a very compelling and affordable package. The Wise Touch will be available nationwide in early 2012 and when it arrives, there's no doubt it will change the way local consumers are able to interact and engage with the planet's most exciting consumer technology. The question is: *how will it Touch you?*

For further information, contact **Wise Tablets** on:

Tel: **012 667 8888**, Cell: **082 659 3035**, e-mail info@wisetablets.co.za or visit the Web site at www.wisetablets.co.za



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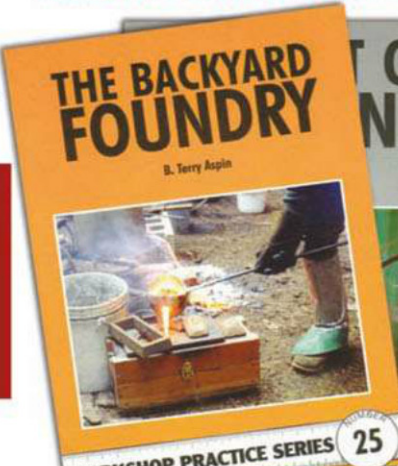
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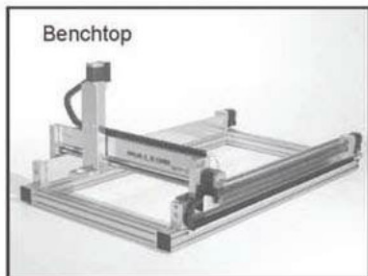
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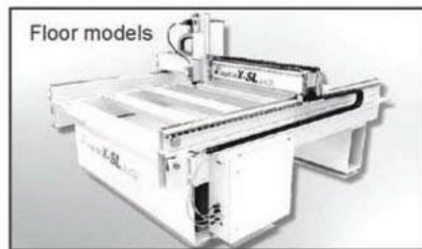
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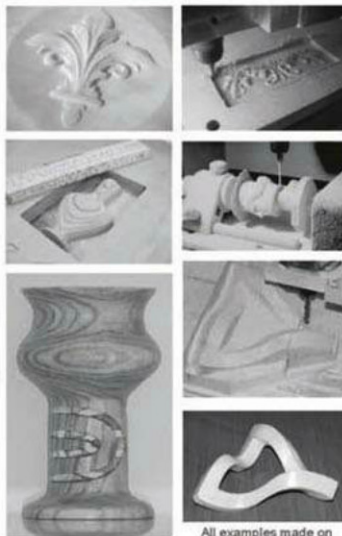
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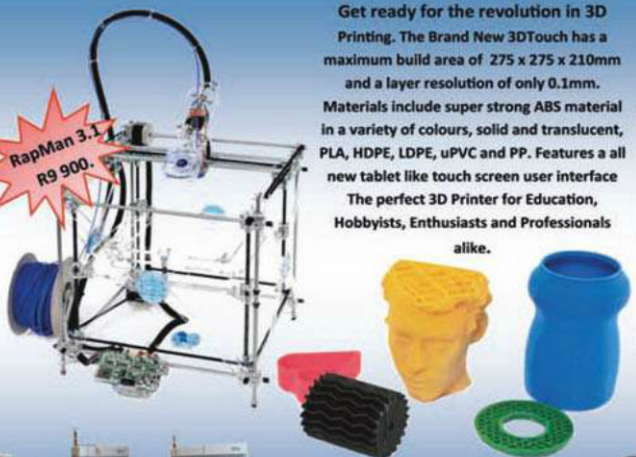
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E DAVIES
PARYS



Baking soda's not just for baking

If you've burned the bottom of your cast-iron potjie, don't fret. Rather than soaking it for days on end, try this simple tip instead.

First sprinkle a generous layer of baking soda (bicarb) over the pot's burnt bottom, add just enough water to moisten the baking soda, then leave the solution to work its magic for several hours – the burned material should just peel right off.

GLORIA HUMPHREYS
WITBANK

Shaving costs

My girlfriend, deciding that we needed to start a budget, shared her monthly cosmetic costs with me. I was shocked by how much she spent on disposable nail files – R50 and up! So I took one of her old files to the hardware store and bought sanding paper of a similar roughness. Using the file, I marked its dimensions on the back of the sanding paper, cut it out, glued it on to

the worn file with my glue gun and, Voilà! She even reckons it works better than the original. I've managed to renew 12 old files with a single sheet of sanding paper. She normally buys three files a month; these were costing her R1 800 annually. By buying three sheets of sanding paper for under R10 each and adding R10 for a glue stick, I'm helping her save R1 760 a year. Not bad if you live on a tight budget!

HENNIE GOUWS
PRETORIA

Eco-friendly bird food

Doing a fry-up for breakfast? Don't chuck that leftover fat down the drain or in the bin. Instead, cut up any old stale bread into small pieces (or make crumbs in a blender), put the bread into the pan, give everything a bit of a stir (so that the bread is evenly coated) and then put it out for the birds. This can be done with any leftover fat, even when frying fish, and the birds love it.

CILLA NEL
PETIT

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Send us your best home, garage, workshop and general DIY hints – and win! This month's prize is a Makita 14,4 V cordless impact driver/drill valued at R2 299. This compact and versatile power tool has three work modes – percussion drilling, drilling and screw driving. It features all-metal gears for durability and a single-sleeve keyless chuck that allows for easy bit installation or removal with one hand. For more information, visit www.makita.co.za or contact Rutherford Johannesburg on 011-878 2600, Durban on 031-717 6400 or Cape Town on 021-932 0568.

Send your tips to: PM Do It Your Way, Box 180, Howard Place 7450, or e-mail: popularmechanics@ramsaymedia.co.za Please include your name, address and contact number. Regrettably, only South African residents are eligible for the prize. Prizes not claimed within 60 days will be forfeited.



For the love of steam

If your expensive iron is not steaming properly, there's a good chance accumulated mineral deposits are to blame. To solve this, add some vinegar to the water reservoir and then place the iron flat in its holder on the ironing board. Plug in the iron and turn it to the steam setting. When the iron has finished steaming, it should now be clean and ready to use.

SIMON PIETERSEN
RANDBURG

Keep your tools rust-free

Living on the south KwaZulu-Natal coast, I find rust to be a big problem. So, every time I receive a package that contains those little silica-gel packets, I place them in toolbox drawers and power-tool cases, where they absorb moisture and help keep my tools rust-free.

SIMON DALE
SCOTTBURGH PM

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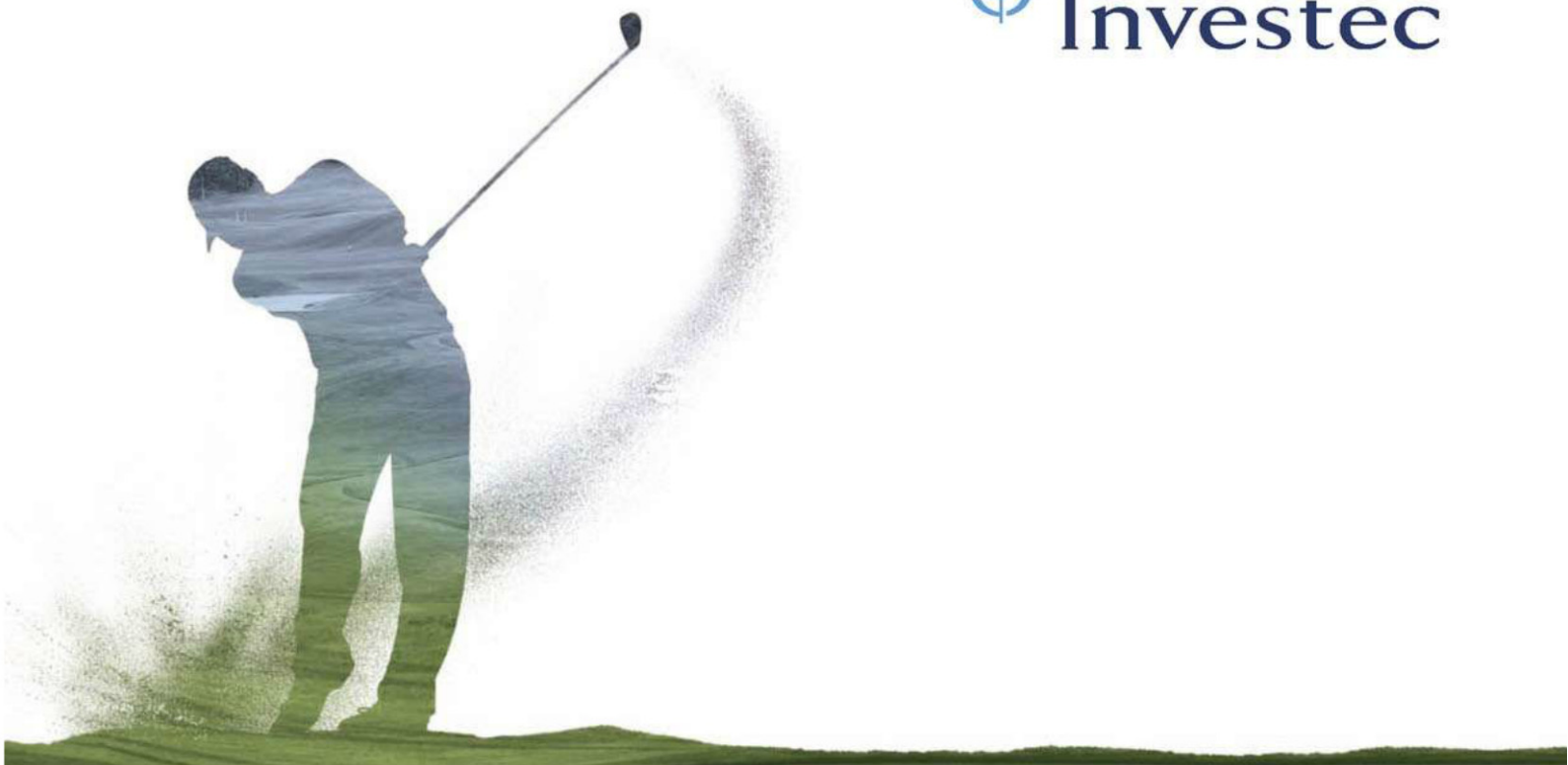
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